TECH TECH
PUBLIC LIBRARY
SEP 22 1937
DETROIT

EDISON ELECTRIC INSTITUTE BULLETIN

SEPTEMBER, 1937

Cycles and Service . . . . . C. W. KELLOGG 353

From Wisconsin to the TVA . . . . . F. A. NEWTON 355

New Magazine to Promote Power Sales 358

Twenty Per Cent of Farms Fail to Take Service 359

Electrical Standard of Living Program by G. E. 360

What the Utilities Are Doing to Promote Air Conditioning 361

Rural Electrification Program of Niagara, Lockport and Ontario Power Company 367

Practical Aspects of Cavitation and Pitting . . . . J. M. MOUSSON 373

Kitchen Modernizing Movement Covers Entire Country 384

Meter Reading Work—A Function of Customer's Accounting . . . . . E. M. WAGNER and L. M. LA PORTE 385

Performance Tests on Non-Metallic Sheathed Cable for Underground Network Mains . . . . C. W. PICKELLS 391

Refrigerator Sales, 396—Power Sales Items, 399

Conventions and Meetings, 400

EDISON ELECTRIC INSTITUTE

STATISTICAL DATA OF THE ELECTRIC LIGHT AND POWER INDUSTRY

Compiled Monthly by the Edison Electric Institute—Covers 100% of the Industry

DURING THE MONTH OF JUNE

	1937	1936	%
Kilowatthours Generated* (net)			
By Fuel	6,072,623,000	5,573,337,000	+ 9.0
By Water Power	3,490,627,000	2,932,266,000	+19.0
Total Kilowatthours Generated	9,563,250,000	8,505,603,000	+12.4
Additions to Supply			
Energy Purchased from Other Sources	303,702,000	172,341,000	+76.2
Net International Imports	108,380,000	113,951,000	− 4.9
Total	412,082,000	286,292,000	+43.9
Deductions from Supply			
Energy Used in Electric Railway Departments	42,042,000	41,848,000	+ 0.5
Energy Used in Electric and Other Departments	114,402,000	109,900,000	+ 4.1
Total	156,444,000	151,748,000	+ 3.1
Total Energy for Distribution	**9,818,888,000**	**8,640,147,000**	**+13.6**
Energy Lost in Transmission, Distribution, Etc.	**1,491,867,000**	**1,376,044,000**	**+ 8.4**
Kilowatthours Sold to Ultimate Consumers	**8,327,021,000**	**7,264,103,000**	**+14.6**
Sales to Ultimate Consumers (kwhrs)			
Domestic Service	1,341,801,000	1,144,307,000	+17.3
Commercial—Small Light and Power (Retail)	1,463,154,000	1,274,511,000	+14.8
Commercial—Large Light and Power (Wholesale)	4,889,332,000	4,196,958,000	+16.5
Municipal Street Lighting	136,088,000	159,124,000	−14.5
Railroads—Street and Interurban	326,917,000	346,241,000	− 5.6
Railroads—Electrified Steam	97,656,000	74,498,000	+31.1
Municipal and Miscellaneous	72,073,000	68,464,000	+ 5.3
Total Sales to Ultimate Consumers	8,327,021,000	7,264,103,000	+14.6
Total Revenue from Ultimate Consumers	$178,538,700	$164,007,200	+ 8.9

DURING TWELVE MONTHS ENDING JUNE 30th

Kilowatthours Generated* (net)			
By Fuel	72,649,417,000	61,680,435,000	+17.8
By Water Power	39,623,968,000	36,889,461,000	+ 7.4
Total Kilowatthours Generated	112,273,385,000	98,569,896,000	+13.9
Purchased Energy (Net)	3,913,892,000	3,239,779,000	+20.8
Energy Used in Electric Railway and Other Departments	2,128,737,000	2,181,955,000	− 2.4
Total Energy for Distribution	**114,058,540,000**	**99,627,720,000**	**+14.5**
Energy Lost in Transmission, Distribution, Etc.	**17,906,029,000**	**16,684,316,000**	**+ 7.3**
Kilowatthours Sold to Ultimate Consumers	**96,152,511,000**	**82,943,404,000**	**+15.9**
Total Revenue from Ultimate Consumers	**$2,134,371,300**	**$1,972,559,800**	**+ 8.2**
Important Factors			
Percent of Energy Generated by Waterpower	35.3%	37.4%	
Domestic Service (Residential Use)			
Average Annual Consumption per Customer (kwhr)	762	697	+ 9.3
Average Revenue per Kwhr (cents)	4.54¢	4.86¢	− 6.6
Average Monthly Bill per Domestic Customer	$2.88	$2.82	+ 2.1

BASIC INFORMATION AS OF JUNE 30th

Generating Capacity (kw)—Steam	24,085,600	23,966,500
—Waterpower	9,521,200	9,011,600
—Internal Combustion	615,400	499,400
Total Generating Capacity in Kilowatts	34,222,200	33,477,500
Number of Customers		
Farms in Eastern Area (Included with Domestic)	(852,131)	(626,271)
Farms in Western Area (Included with Commercial—Large)	(286,204)	(233,767)
Domestic Service	22,105,787	21,333,916
Commercial—Small Light and Power	3,851,151	3,777,444
Commercial—Large Light and Power	549,378	495,783
Other Ultimate Consumers	70,331	62,138
Total Ultimate Consumers	26,576,647	25,669,281

* By courtesy of the Federal Power Commission, with deductions for certain plants not considered electric light and power enterprises.

Vol. 5, No. 9, EDISON ELECTRIC INSTITUTE BULLETIN; published monthly. Entered as second-class matter Aug. 17, 1933, at the post office at Philadelphia, Pa., under the act of March 3, 1879. Publication office, 56th and Chestnut Sts., Philadelphia, Pa. Editorial office, 420 Lexington Ave., New York, N. Y. Subscription rate, $2.00 per year in the United States; $3.00 per year in foreign countries.
The Edison Electric Institute does not assume responsibility for, nor necessarily endorse or approve, statements made by contributors to the BULLETIN.

EDISON ELECTRIC INSTITUTE BULLETIN

Volume 5 SEPTEMBER, 1937 No. 9

Cycles and Service

By C. W. Kellogg
President Edison Electric Institute

A talk before the Pennsylvania Electric Association, Bedford Springs, Pa., Sept. 10, 1937

WE STAND at the beginning of another year. The cycle of nature (differing from our fiscal calendar) is complete with the gathering of the crops which the summer sun has ripened. Plowing and planting for winter wheat is upon us; it is really now that 1938 is beginning. It is a time to take stock.

The whole of our world is a series of cycles; some, like the light ray, of a frequency beyond the human understanding in size; others, like geological changes, are slow beyond our human comprehension. Our electric service, while delivered in flashes 120 times a second, yet has its much longer movements, some of many years' duration. Where do we stand in the long cycle?

While still in the prime of life, I can hardly remember the time when electricity was not working among us. As a boy of seven I saw the first electric street-car in Boston, 50 years ago, and yet when I started in the electric utility business nearly 35 years ago its total output was about 2% of its present size.

This 35 years of phenomenal growth has required the raising of 12 billion dollars of capital. Building up the investor confidence necessary to attract this huge block of capital has been fully as arduous a task as the engineering skill required to produce dependable service, the commercial effort needed to educate the public to use the service and all the other multifarious activities which together have contributed to make the electric development of the United States the model and envy of the rest of the world. The recent report of the National Resources Committee states that the per capita consumption of electricity in the United States is 68% larger than in Great Britain, 70% greater than in Germany, 91% greater than in France and 156% larger than in Italy.

A great deal has been said in a critical way in recent years about the cost of electricity, yet the same National Resources Committee report shows that in the 35 years since 1902 the average selling price of a unit of electricity for household purposes has been reduced from over 16c to about 4½c.

Every industry has its own peculiarities, failure to realize which causes public misunderstanding. The electric utility industry has three such special characteristics to which I will direct your attention at this time. The first is the exceptionally large amount of fixed capital required to furnish the service. The ratio of fixed capital to annual gross receipts is seven times as great for electric utilities as for the average industrial enterprise, so that while the central station industry ranks fifth among the industries of the nation in size of its investment, it stands but thirteenth in point of value of its annual product.

The second peculiarity of the electric utility business is that though its earnings do bulk very large, yet it consists essentially of many millions of very small retail transactions. Taking four people per family, the average cost of electricity per capita in the 21,000,000 homes served by the privately-owned utilities is only about 2¼ cents per day. With all the conveniences and labor-saving which electricity brings into the home besides the essential of illumination, the total electric bill represents but 2% of the average family budget.

The third peculiarity is the paradox that while in the public mind the great problem of electricity is the cost of producing it, the facts are exactly reversed. The manufacture of the electricity itself represents but a quarter of the total cost, whether from the viewpoint of operating cost or of plant investment involved. So that the part of the electric bill representing electric energy alone represents but ½%—one two-hundredth of the average family budget. This statement is based on the average for the entire electric business; for residence service alone (on account of the relatively higher distribution cost with this class of business) the proportionate part of the cost represented by energy alone is substantially less than for the whole electric industry.

These peculiarities of the electric utility business have a direct bearing on the matter of government power policy. If, for example, it should be proposed that the power produced from government dams be delivered free to the people at the plant switchboard, how much would this cost the average man as a taxpayer and how much would it save him as a consumer? Even free electricity at the switchboard would still have to be distributed to the people and, as has just been pointed out, the cost of distribution is three times as great as the cost of the energy to be distributed.

The average saving to the householder from free government energy would therefore be about 2¼c per day. Nation-wide statistics published by the U. S. Department of Commerce indicate that this amount is less than he has

averaged to pay in the past for ice cream and candy or cigarettes or some other similar items in the family budget. Yet on account of the high ratio of investment to earnings in the electric business, the total cost to the taxpayers, of whom he is one, would be immense. How do you suppose the public would react to a proposal to have the Government furnish free soft drinks, candy, ice cream or cigarettes? Yet, fantastic as this may sound, these savings to the householder would not only be greater than from free electric energy at Government power plants but could be made for him at much less cost in taxes. In fact, there is practically no line of business in which the saving in cost to the taxpayer could be so small from a given expenditure of tax money as in the electric business.

In order to get the relative perspective between electricity and taxes, let us examine the tax burden. At the present time the total taxes paid annually in the United States amount to about ten billion dollars. With 130 million population and four to the family, this makes an annual burden on each household of about $308, or about 84 cents a day. Comparing this with the 2¼c, which his quota of undistributed electric energy costs, strikes at the heart of the problem. It means that if his taxes could be cut say one-tenth it would save him over four times as much as a taxpayer as the theoretical free electric energy from Government plants we have discussed would save him as a consumer.

These figures go far beyond the mere question of allocation of costs as between electric power, navigation, flood control and the like in Government projects. They have no regard to whether the policy should be to soak the utilities; they pass by the question of whether the investor in the utilities is entitled to consideration—they become a very practical question of how much the citizens want to tax themselves and how they can get the greatest cash return to themselves from this self-imposed tax burden.

Going back to our cycle analogy, where do we stand now? I feel we have passed through many phases in learning our own business and in extending our field of operation, but that for the future the essential is to confine ourselves strictly to the fundamentals of service.

It may seem trite to say it, but our sole function in the body politic is to furnish the best possible electric service to the largest number of people on the broadest possible basis and at the lowest feasible cost. That being the sole reason for our existence, we shall achieve the maximum success in our enterprise in the proportion that we attain perfection in the development of that sole function.

This objective is much easier to state than to attain. The word "service" includes every detail which contributes to the final product—the raising of capital to construct and extend our plants, the planning, design and construction of our properties to produce electric energy, ample in quantity, dependable in quality and widely diffused; the sales activities which bring to the people's attention the blessings that electricity can confer upon them; the policies and methods for assuring harmonious relations between our companies and our customers. All these and many more are included in the one word "service" because that word, understandingly used, comprehends every feature of our business.

But service also means devotion—at least, willing, enthusiastic service, does —and that is the only kind worth striving for. In the organization to which I have devoted the entire 35 years of my business life we have an expression for the frame of mind of a man who goes stale on the job from any of the reasons that cause such a condition. We say he gets to "working for money." That is to say he gets to thinking about what he can get out of the job instead of what he can put into the job. Obviously until this viewpoint can be corrected by a vacation or a change or in some other way, the man's efficiency and usefulness are greatly impaired.

One of the great truths of all human experience is that we get what we give in this world and the man who starts out only to get and not to give will generally end by doing neither. The essence of service is to do things for other people and it is the reaction of the basic human principle I have cited that gives that sense of enthusiasm and satisfaction that permeates every utility organization which is successfully performing its service function.

Shakespeare said that the actor holds the mirror up to nature. We all do the same every day of our lives. Your great Franklin tells the story of meeting a young stranger on the streets of Philadelphia and being asked by him what sort of people there were in Philadelphia. Franklin countered by asking what sort of people there were where the young man came from, to which the latter replied that they were mostly mean, crabbed folk. Franklin told the young man that he would find most of the Philadelphians mean and crabbed, too. Later he met another young stranger and asked the same question. This young man replied that where he came from the people were wonderful, kindly and cooperative. Franklin assured this young man that the kindly, cooperative folk vastly predominated in Philadelphia. Franklin justified the apparent inconsistency of his two differing reports upon the same grounds that Shakespeare discovered, namely, that we are all mirrors and that what we get from others is but the reflection of our own image.

Stated even more broadly, human nature is the same everywhere and may be expected to mirror accurately the spirit and efficiency of the service furnished it.

So far as individual contacts are concerned, the process I have described is immediate and automatic and the grand total of service relations is but the sum of the millions of elements that go to compose it. Large bodies move slowly, however, in proportion to their size, and for this reason general public relations require both faith and patience—faith in the fundamental fairness of people, patience to await the inevitable final reaction to good, economical and human service.

Going back to the cycle figure, I feel the history of our industry shows the effect of all the apparent platitudes I have been giving forth in my talk. There is no doubt that we reached a stage in our development some years ago when we got to "working for money". There was a perfectly valid reason for this condition, in the pressing need for equity capital on the part of companies too small to possess the credit to raise it. There is a reason for everything in this world, but for this discussion I am simply emphasizing the historic fact that we got to "working for money". And it got us into plenty of trouble.

It led to the Federal Trade Commission investigation of a decade ago. That in turn brought in the familiar pendulum effect in human relations, which often causes corrective movements to go beyond their objective once the momentum is acquired, and produced a surge of public sentiment to the effect that the

(*Continued on page* 400)

From Wisconsin To the TVA

By F. A. Newton
The Commonwealth & Southern Corporation

An address before the Wisconsin Utilities Association, Green Lake, Wis., Sept. 24, 1937

I AM BACK HOME. I was born and brought up in Wisconsin. After leaving the University, I spent several years with what was then known as the Railroad Commission of Wisconsin, being very closely associated with Commissioner Halford Erickson, one of the finest characters I have ever known.

Since that time much water has gone over the dam—lately an increasing amount over government dams. Since that time a former member of the Public Service Commission of Wisconsin, successor to the Railroad Commission, has become one of the directors of the Tennessee Valley Authority, in charge of its power policy and chiefly responsible for its so-called "yardstick" rates.

This leads me to my subject—"From Wisconsin to the TVA." The subject assigned to me on the program is "The Outlook for the Utility Industry." I am not departing from that subject. Certainly, there can be nothing of more vital importance to the future of the electric utility industry than the TVA and its children, the seven little TVAs, now before Congress for christening.

The Director of Power of the TVA, while a member of the Wisconsin Commission, had one of the most wonderful opportunities to investigate the cost of producing and distributing electricity any Commissioner in this country ever had. The Wisconsin Public Utility Act is one of the most comprehensive of its character ever written. Wisconsin was one of the first two states to provide for thorough regulation of public utilities. The Wisconsin Legislature passed the Public Utility Law on July 9, 1907. This was but a month subsequent to the passage of the Regulatory Law in New York. Regulation of Wisconsin utilities by the original Railroad Commission and its successor, the Public Service Commission, has been very searching since the enactment of the Act in 1907, which was 30 years ago. The Commission's jurisdiction over privately owned electric utilities extends as far if not farther than in any other state in the country. It has jurisdiction also over municipal plants—an unusual situation.

The Wisconsin Utility Act called for the appraisal or valuation of all utilities in the State. The records of the Commission showing costs and statistics of operation of the electric utilities under its jurisdiction constitute one of the most extensive collections of such data available in this country and including municipal as well as privately owned companies.

At the time the Act was passed in 1907, municipal and privately owned electric utilities in Wisconsin had 44,081 customers. By 1932, the number of customers had increased to 632,043—in other words, multiplied nearly 14½ times. The total generating capacity during the same period increased from 40,711 kw to 850,000 kw, an increase of 21 fold. The total revenue of the electric utilities in the State amounted to $2,127,000 in 1907. This had grown to $47,357,000 in 1932. These figures reflect the growth of the electric utility industry in Wisconsin during the first 25 years of regulation.

Some of the oldest, best established and most efficiently operated electric utilities are found in Wisconsin. You have here interconnected systems—"Grids"—if you please. You have hydroelectric power as well as steam power. You have utilities operating in congested territories and large cities as well as in many small localities and in thinly popuated territory. In other words, the electric utility industry in Wisconsin is a representative cross-section of the electric utility industry of the United States.

All of these records and all of this information were available to the Director of the TVA while he was a member of the Wisconsin Public Service Commission. While a member of the Commission, however, no order was issued establishing rates in Wisconsin anywhere near as low as the so-called "yardstick" rates of the TVA. Here in Wisconsin was an established business with a long record of costs and operation. The TVA was a new business with no record available when the "yardstick" rates were adopted.

What is there about the TVA situation which enables it to make such low rates? Or, to put it in another way, what is there about the Wisconsin situation which prevented the making of such low rates here? Probably the chief reason is that members of the Wisconsin Commission must be guided by facts and by well established principles of law. The Power Director of the TVA is not subject to such restrictions.

Let us examine the TVA situation to see if we may find why such low rates are possible. There are a few facts which have been stated repeatedly and never denied by the TVA which probably go a long way toward explaining why what could not be done in Wisconsin has been done by the TVA.

Electric utilities, including those in the Tennessee Valley, pay local, state and federal taxes amounting to 15 per cent of the gross earnings. You in Wisconsin pay 16½ per cent of your gross earnings in taxes. Taxes are a part of the cost of electric service. Taxes have to be paid by the utilities and in turn paid by the customers. Taxes paid by the TVA have been inconsequential so far. Even with a fully developed business, its taxes will not exceed 5 per cent of its gross earnings. The Tennessee Electric Power Company, in 1936, shows as a part of its operating expenses, taxes amounting to over $2,500,000, or approximately 17 per cent of its gross earnings. The TVA, in its last annual report, shows tax payment amounting to $45,347.39 for the fiscal year 1936, on property greater in value than that of The Tennessee Electric Power Company.

The TVA has available, the facilities of the government's printing office. You have no such facilities at your disposal. The TVA, being a governmental undertaking, makes use of the franking privilege on its mail. You have no such privilege. The TVA, as a governmental undertaking, is granted preferential freight rates on materials and supplies it uses. Nothing of this kind is available to you.

The Wisconsin Public Utility Act, as well as all similar acts throughout the country, provides that the electric utilities in Wisconsin must make adequate provision for depreciation. All regula-

tory commissions recognize depreciation as an essential part of the cost of furnishing electric service. It is no small part of such cost, either. The Tennessee Electric Power Company, for example, by order of the Tennessee Commission, makes a provision of $1,260,000 per year for depreciation. No depreciation item of cost will be found in the TVA report. In its Balance Sheet as of June 30, 1934, it included a credit to Depreciation Reserve of $82,618.74. Such amount was criticized by the then Comptroller General of the United States as entirely inadequate and he recommended that it should be at least $1,000,000 per year.

You, in Wisconsin, like all other electric utilities, must pay interest to your bondholders, or upon any money you borrow. The Wisconsin Public Utility Law, like all laws of similar character, says very plainly that the utilities are entitled to a fair return on their investment and that this is an essential part of the cost of furnishing electricity.

Now, we will not argue about what is a fair return, whether it should be 5 per cent, 6 per cent, 7 per cent or some other per cent. In any event, however, interest has to be paid. TVA, however, pays no interest. Its poperty was turned over to it by the government or built by moneys upon which it pays no interest. True, the TVA has been authorized to issue $50,000,000 of bonds bearing not to exceed 3½ per cent interest, but it has not seen fit, as yet, to sell any of this issue. The TVA has also been authorized to issue $50,000,000 of 3½ per cent bonds, the proceeds from which it may use to broaden its power market by assistance to municipal plants and non-profit organizations in acquiring electric distribution facilities. Neither has this issue been sold to date.

How can there be an honest "yardstick" to measure the reasonableness of rates charged by private electric utilities in view of such subsidies and privileges? And this is not all of the story. The TVA was called upon by Congress to determine and allocate to power production, the proper part of the investment in the dams and other facilities. As late as in June, 1937, the TVA advised Vice-President Garner that it was not yet ready to make its report and findings on this question. In other words, the TVA does not know, Congress does not know and the public does not know, what investment it has in electric power production.

In addition to the advantages and subsidies which make possible the "yardstick" rates of the TVA, municipalities have been offered by the government from 30 per cent to 45 per cent of the cost of the municipal distribution system to be a gift, never to be repaid and upon which the municipality pays no interest whatsoever.

There is, further, a very interesting sidelight on the "yardstick" rates of the TVA for domestic customers. For the 12 months ending July 31, 1937, the commercial customers in the towns using TVA electricity used over twice as much electricity per customer as the residential customers in the same towns. Yet these commercial customers paid an average rate nearly 30 per cent higher than that paid by the residential customers. These figures arouse in me, and perhaps they will in you also, some wonder if such a discrepancy between residence and commercial rates would not receive the condemnation of the State Regulatory Commissions as unjust discrimination. Maybe this wide difference between commercial and residential rates helps to explain the low residential "yardstick" rates of the TVA.

Dr. A. E. Morgan, Chairman of the TVA has been very careful several times to define what, in his opinion, constitutes an honest "yardstick." No one, to my knowledge at least, has ever disputed the fairness and honesty of his definition. He said:

> "In case public power is used as a 'yardstick' or as a measure of what the private power industry should charge for its services, then it is imperative that records and accounts be honest and fair and open, and that there be no hidden element of subsidy. The very fundamental element of such comparison is honesty, fairness and openness in measurement. Take away those characteristics and the supposed comparison may becloud the issue, rather than clairfy it."

He said as clearly as anyone can say it:

> "And if they are to serve as comparisons, they must be open and aboveboard, with nothing hidden. They must be fair, with no special arbitrary advantages. They must pay taxes, just as private utility companies must do and every other reasonable charge, if they are to provide us with a fair comparison."

I assert without fear of contradiction that there is not a comparable utility system in the country, including Wisconsin, which needs, for one moment, to have any fear of "yardstick" rates, conceived and established in accordance with the definition laid down by Dr. Morgan. Or, to put it in another way, as publicly announced by Mr. Wendell L. Willkie, President of The Commonwealth & Southern Corporation, The Tennessee Electric Power Company, if given the same subsidies and advantages as given to the TVA, could and would establish rates for electricity materially lower than those specified in the TVA "yardstick."

So much for the "yardstick" rates and the subsidies and privileges upon which they are based. Let us ask the question, what is the necessity for these "yardstick" rates? What is the reason behind the creation of the TVA and the subsequent drive to create seven other TVAs to cover practically the entire country? What is all the shouting about? How cheap is domestic electricity and how cheap should it be? Let us look at a few facts about the cost of electricity to the domestic customers of this country and see if there is anything in these facts that appears to justify the scheme which will destroy the private utility industry and substitute public ownership in its place. There are over 21,000,000 domestic users of electricity in the United States. What do they pay for the electricity they use? In 1936, the average bill of all of these families for residential and farm electricity was $33.72 which is an average of approximately 9 cents per day per family—less than a dime a day. Is there anything about that cost to get excited about?

Here are a few facts with which you are probably familiar, but they deserve to be repeated because they have so important a bearing on the relative value of the electricity to the homes of this country. In the year 1936, less than 2 per cent of the average family's budget was expended for electricity. Recent figures issued by the WPA on the cost of living in 59 cities in the United States, for a four-person manual worker's family show that the cost of electricity is approximately 1½ per cent of the total cost of living for this family. Electricity is the smallest item in the list.

In the year 1935, the expenditure for admission to motion picture theaters was $750,000,000, nearly $50,000,000 more than all of the residential and farm customers in the United States paid for all of the electricity they used. I do not know what the relative value is of movies and electricity to the people of this country, but there ought to be something in these figures to think about. What is the relative value of liquor and tobacco

Make Your Plans To Attend

THE EEI NATIONAL ACCOUNTING CONFERENCE

Book-Cadillac Hotel
Detroit, Michigan

NOVEMBER 8, 9, 10, 1937

Program in Brief

Monday, November 8th—	10:00 A M.....	Committee Meetings
	2:30 P M.....	General Session—Systems of Accounts and Related Matters
Tuesday, November 9th—	10:00 A M.....	General Session—Plant Accounting; Depreciation; Original Cost Problems; Retirement Units; Construction Overheads; etc.
	2:30 P M.....	Continuation of morning session
	7:00 P M.....	Dinner (2 speakers of national prominence)
Wednesday, November 10th—	10:00 A M.....	General Session—Specialized Accounting Subjects; Commercial; Social Security; Purchasing, Stores & Transportation; Cost Allocations in Combination Companies; Job Classification, etc.
	2:30 P M.....	Continuation of morning session

Committee Chairmen

Accounting Committee—Mr. B. S. Rodey, Jr., Consolidated Edison Co. of New York, Inc., N. Y. C.

Customers' Relations, Commercial Accounting and Collections—Mr. K. E. Boyle, Dayton Power & Light Co., Dayton, Ohio.

General Accounting and Records—Mr. F. P. Dexter, Engineers Public Service Co., Inc., N. Y. C.

Plant Accounting and Records—Mr. H. D. Anderson, American Gas & Electric Company, N. Y. C.

Purchasing Stores and Transportation—Mr. E. C. Brock, Public Service Electric & Gas Co., Newark, N. J.

The complete program and further details of the program will be published in the October E.E.I. Bulletin.

and domestic electricity? I do not know, but I do know that the American people pay one and one-half times as much in federal taxes, alone, on liquor and tobacco as they pay for their entire consumption of electricity. The total cost of electricity to all the families in the United States is less than American automobile owners pay in taxes on gasoline—not for the gasoline they use—but just for the privilege of buying it. Something seems to be wrong here somewhere.

Here is something to think about. The expenditures of the federal government, according to the budget, and exclusive of debt retirement and adjustment compensation payments, will amount to $7,512,799,000 in the fiscal year 1937. A saving of but 10 per cent in federal expenditures would therefore be enough to pay all of the electric bills of all the farms and homes in the United States for the year. But on the contrary the budget estimate is that there will be a further increase in federal expenditures of nearly $710,000,000 which increase in federal expenditures, alone, would nearly pay the entire domestic electric bill of the whole country.

The electric utility industry has reduced the price of its product to the homes of this country, 46 per cent since 1913, while, at the same time, the cost of living has increased over 44 per cent. No other industry whose product enters into the cost of living in the American home can even approach the accomplishments of the privately owned electric utilities in reduction in price and improvement in efficiency. At the same time, electric service has been brought to every city and practically every village in the United States and to most of the small hamlets. Here is a record to be proud of and yet the industry is held up to scorn and subjected to the test of unfair "yardstick" rates based upon subsidies and privileges, and all over an item in the family budget of the least importance to the American Public.

There would seem to be some other

purpose than a desire to furnish cheap electricity behind the TVA and similar projects. Many people have arrived at the conclusion that the underlying purpose is to destroy private investment and socialize the electric utility industry. Probably their conclusion is best expressed by General Hugh S. Johnson who said:

"Are these dams worth anything for flood control? Flood control suggests an empty reservoir—these dams are intended for a full one. They obviously have nothing to do with erosion as is so ardently proclaimed.

"In view of the increased efficiency and low cost of steam, as compared with hydro-electric power in a land of coal, is this construction warranted?

"Are there not so many concealed subsidies here as to make the so-called yardstick a fraud?

"Has this not recently become a pure punitive expedition aimed at destruction of a vast private investment at the command of revengeful and death-seeking Senators, who were able to divert the administration from its original announced policy and attempted pool arrangement, by threatening sabotage of its court proposal?"

and he further said:

"For power production and river control, TVA is magnificent. But like the St. Lawrence seaway, it is not primarily a navigation project, but a power project. Why does the federal government so frequently have to go sneaking around in false faces?"

In the face of the facts with respect to the "yardstick" rates of the TVA and the subsidies and advantages upon which those rates are based; in the face of the facts as to the unparalleled accomplishments of the privately owned utilities in improved efficiencies and reduced prices and in the face of the fact that there is no real justification for the expenditure of hundreds and millions of taxpayers' money on these projects, one is forced to the conclusion arrived at by Dr. Morgan and expressed in the *Atlantic Monthly* for September of this year, wherein he said:

"The writer is a *minority* member of the Board of Directors of the Tennessee Valley Authority, of which he is the Chairman. In important respects he differs from what he *judges* to be the *actual* power policy of his associates. This statement, therefore, reflects his personal views, and not the working policy of TVA on the power issue. Neither does it undertake to criticize in detail what the writer believes to be the *improprieties* of that policy."

Finding no aid or comfort in the record of the privately operated electric utility with respect to efficiency and price, the public ownership advocates resort constantly to the practice of dragging in the name of some past executive of the utility industry who they claim violated his trust to his investors. They would ask the public to condemn a whole industry for the errors and mistakes of a few. What industry has escaped such incidents? Have all those who have sat in high places in government been faultless and have they avoided mistakes? In any event those evils which may have existed, and there is no use to deny that some of them did exist, have been eliminated by the legislation which created the Securities & Exchange Commission and by the laws upon which the Federal Power Commission's regulations are based. The industry is free of those evils today and under this legislation will be free in the future. Constantly dragging in the names of a few past executives and the raking up of old mistakes is nothing but an effort to mislead and confuse the public and to arouse prejudice for political purposes.

Electrified Industry—New Magazine To Promote Power Sales

ELECTRIFIED INDUSTRY, a monthly news and picture magazine of national coverage planned to promote the use of electric service by American industry will make its initial appearance in October under the guidance of B. J. Martin, formerly editor of *Electric Light and Power*, as editor and publisher.

The new magazine will publicize the economy of purchased power and show how production in industry can be improved by the more generous use of electricity. Its circulation starts at 12,000, with power companies in Boston, Philadelphia, Baltimore, Pittsburgh, Cincinnati, Chicago, Milwaukee among those which have already contracted to have the magazine sent direct to their industrial customers.

While a group of nationally known electric light and power men will serve as an advisory committee on editorial policy, *Electrified Industry* will be "edited in the field," that is the articles will be based on personal interviews with power users and inspections of the power installations by the editorial staff, and the articles written from the customers' point of view.

Each month industrial and office lighting, electric heat, motor applications, wiring and maintenance, ventilation and air conditioning will be featured, while frequent discussions will deal with shop trucks, conveyors, space heating, cooking and special electrical problems and applications.

The magazine will be profusely illustrated with pictures with the practical applications of electric power and the personalities concerned with the particular installations discussed. Its text will take its readers among American industrialists, and give them human interest stories of business success and the part electric service plays in the production of world famous products.

Gov. Aiken on the Flood Control Compact

Excerpt from a dispatch in New York Herald-Tribune, Sept. 16

"ATLANTIC CITY, Sept. 15—Flood control and water rights in the basins of the Ohio, Connecticut and Delaware rivers occupied the attention today of nineteen Governors assembled for the annual Governors' Conference in the Hotel Traymore. * * *

"Gov. Aiken of Vermont said "that a resolution introduced into both houses of Congress last August authorizing a flood control compact between the four states was unacceptable to New England and certainly to Vermont. This resolution contained the provision that all reservoir sites and all power and storage sites connected with any development should be transferred to the Federal government.

"That there were instant and practically unanimous opposition to this resolution from the New England states was to be expected," Governor Aiken said. "Dozens of towns receive a considerable

(*Continued on page* 397)

Twenty Per Cent of Farms Accessible to Lines Have Failed to Take Electric Service

TWENTY per cent of farm homes in the United States accessible to electric power lines have not taken electric service, C. W. Kellogg, President of the Edison Electric Institute, reports in releasing the results of a survey of farm electrification just completed by the Institute.

The survey shows that occupied farmsteads within reasonable connecting distance of power company distribution lines total 1,420,635. Of this number, 1,138,335 are using electric service, 120,000 farms having been connected for electric service during the first six months of the year. The total number connected represents 17.5 per cent of all occupied farmsteads and 25.8 per cent of all farms where the dwelling is valued at more than $500. In the adjoining columns is a state by state tabulation showing the number of farms served in each state, the increase during the first six months of 1937 and the degree of electrification in each state. The chart on the following page shows the percentage of farm electrification in graphic form.

In addition to supplying 1,138,335 farm homes, preliminary results of a special study being made by the Institute show that there were an additional 282,300 farms within reasonable connecting distance to distribution lines which are not taking the service.

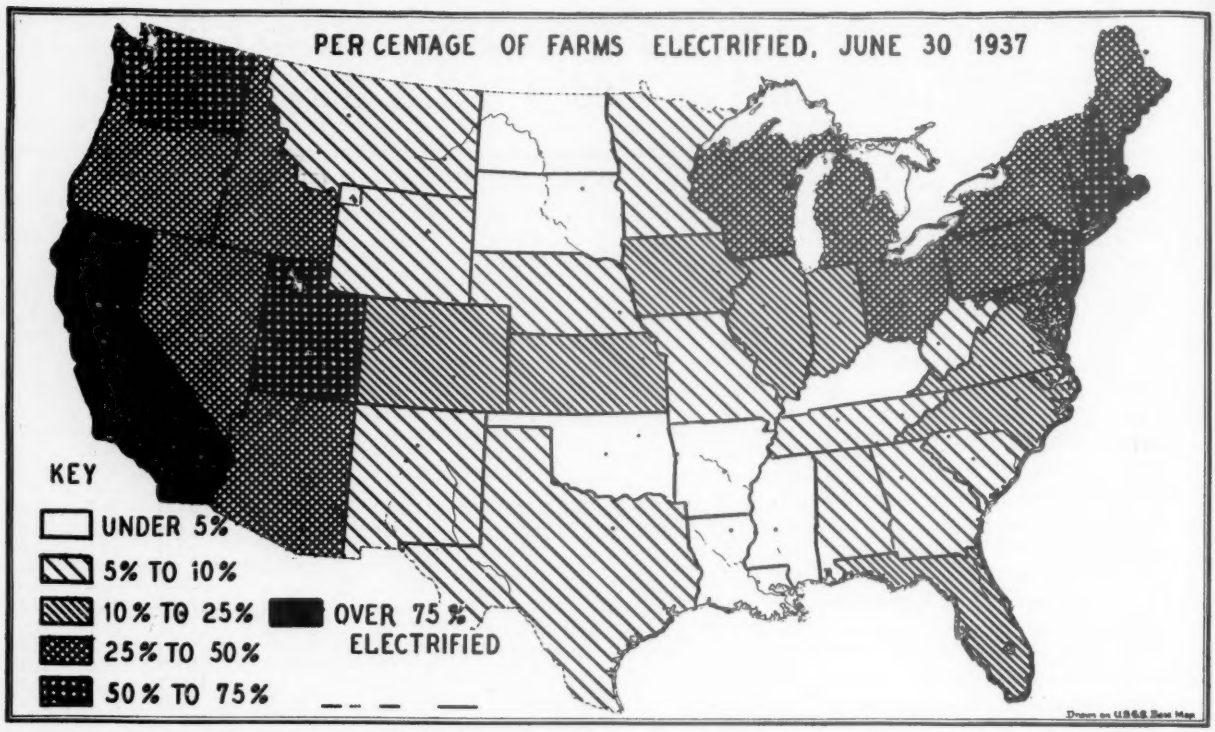
The returns from this study are not yet complete enough in detail to give the number of such farms by states, but it is indicated, however, that except in areas where a relatively high degree of electrification exists the number of farms not taking electric service has considerable relation to the number of "low income farms" as measured by the 1930 Census of Agriculture based on occupied farm dwellings valued at less than $500.

In the New England and the Far Western states, over 90 per cent of the farms on distribution lines are taking electric service. In the Middle Atlantic states 85 per cent and in the Middle West about 80 per cent of such farms are connected, while in the Southern states less than two-thirds of the farms within reach of existing distribution lines have taken the service.

FARM SERVICE—AS OF JUNE 30, 1937

NUMBER AND PERCENTAGE OF FARMS RECEIVING ELECTRIC SERVICE

	Farms Having Occupied Dwellings (A)	Farms Having Dwellings Valued Over $500 (B)	Farms Having Electric Service (C)	Increase First 6 Months 1937 (D)	Per Cent Electrification C/A Per Cent	Per Cent Electrification C/B Per Cent
United States	**6,502,280**	**4,408,284**	**1,138,335**	**119,342**	**17.5%**	**25.8%**
Maine	40,852	36,243	18,594	468	45.5	51.3
New Hampshire	17,477	16,606	11,456	17	65.5	69.0
Vermont	26,179	24,411	8,762	466	33.5	35.9
Massachusetts	33,453	32,842	21,258	376	63.5	64.7
Rhode Island	4,125	4,044	3,738	—33	90.6	92.4
Connecticut	30,048	29,696	19,340	834	64.4	65.1
New England	152,134	143,842	83,148	2,128	54.7	57.8
New York	170,766	164,591	83,567	8,085	48.9	50.8
New Jersey	29,329	28,867	17,858	1,394	60.9	61.9
Pennsylvania	188,688	179,229	80,035	7,884	42.4	44.7
Middle Atlantic	388,783	372,687	181,460	17,363	46.7	48.7
Ohio	246,592	225,984	87,818	13,729	35.6	38.9
Indiana	195,637	172,980	48,345	5,424	24.7	27.9
Illinois	227,138	206,102	45,004	4,908	19.8	21.8
Michigan	191,185	175,074	74,273	11,259	38.8	42.4
Wisconsin	196,501	182,410	50,057	7,434	25.5	27.4
East No. Central	1,057,053	962,550	305,497	42,754	28.9	31.6
Minnesota	197,710	178,846	16,047	2,572	8.1	9.0
Iowa	215,714	208,397	37,622	2,845	17.4	18.1
Missouri	269,556	205,669	23,256	1,161	8.6	11.3
North Dakota	77,822	66,845	2,390	42	3.1	3.6
South Dakota	79,986	66,302	3,245	165	4.1	4.9
Nebraska	130,567	119,953	11,329	2,774	8.7	9.4
Kansas	164,128	140,035	17,364	854	10.6	12.3
West No Central	1,135,483	986,047	111,253	10,413	9.8	11.3
Delaware	10,312	9,615	2,651	262	25.7	27.6
Maryland	43,318	38,254	14,444	813	33.3	37.8
District of Columbia	82	77	61	...	74.4	79.2
Virginia	187,875	132,946	21,262	2,060	11.3	16.0
West Virginia	101,006	72,253	9,720	2,451	9.6	13.5
North Carolina	282,253	156,556	29,546	6,539	10.5	18.9
South Carolina	156,092	59,409	13,921	2,235	8.9	23.4
Georgia	241,142	89,885	15,505	4,826	6.4	17.2
Florida	60,063	36,163	7,603	715	12.7	21.0
South Atlantic	1,082,143	595,158	114,713	19,901	10.6	19.3
Kentucky	260,401	136,582	10,157	394	3.9	7.4
Tennessee	250,612	123,433	21,540	5,302	8.6	17.5
Alabama	260,323	88,857	17,994	3,795	6.9	20.3
Mississippi	297,441	81,134	6,369	554	2.1	7.8
East So. Central	1,068,777	430,006	56,060	10,045	5.2	13.0
Arkansas	245,296	87,402	5,965	387	2.4	6.8
Louisiana	165,558	57,814	7,243	462	4.4	12.5
Oklahoma	203,703	103,452	6,451	461	3.2	6.2
Texas	466,894	263,322	27,418	4,876	5.9	10.4
West So. Central	1,081,451	511,990	47,077	6,186	4.4	9.2
Montana	47,204	28,492	3,703	91	7.8	13.0
Idaho	43,037	31,897	20,555	1,679	47.8	64.4
Wyoming	16,963	10,774	1,547	14	9.1	14.4
Colorado	61,653	43,603	9,264	559	15.0	21.2
New Mexico	38,881	20,903	2,071	71	5.3	9.9
Arizona	18,344	13,263	6,475	66	35.3	48.8
Utah	27,362	22,501	14,365	826	52.5	63.8
Nevada	3,432	2,582	1,271	...	37.0	49.2
Mountain	256,876	174,015	59,251	3,306	23.1	34.0
Washington	82,379	67,032	45,685	3,537	55.5	68.2
Oregon	62,332	50,329	26,916	1,063	43.2	53.5
California	134,869	114,628	107,275	2,646	79.5	93.6
Pacific	279,580	231,989	179,876	7,246	64.3	77.5



Farm connections made during the first six months of the year have been greatest in the Central states, 53,167, or nearly half of all recent connections having been made in these twelve states. In New England, 2,128 farms were connected; in the Middle Atlantic states, 17,363; in the South Atlantic, 19,901; in the East South Central, 10,045; West South Central, 6,186; Mountain states, 3,306; and in the Pacific states, 7,246.

Electrical Standard of Living Program Sponsored by G-E

AN ambitious attempt to bridge the wide gap between the isolated "model" home and the house in which most Americans hang their hats will be launched next month by electric service companies throughout the country. The General Electric Company, which suggested the plan to the industry two months ago, will contribute $60,000 in awards during the next year and a half as part of the program and hopes that materials and equipment manufacturers and others vitally interested in the vast building and modernization market will follow the example, Carl M. Snyder, manager of the company's home bureau, announced. The G-E prizes will consist of cash awards to home builders and modernizers, scrip in $200 units that can be used for the purchase of home appliances, and as a final gesture two completely electrified homes, built to the winners' specifications.

"The fundamental aim of this activity is to persuade people to build better homes and to live better in the homes already built," Mr. Snyder said. "We feel that the tools for accomplishing these ends have been amply demonstrated during the last few years, and in this demonstration the electrical industry has played a major role. Now the time is ripe for a general raising of standards all over the country, commensurate with the progress that has been achieved in electrification and mechanization, air conditioning, the production of better building methods and materials, and simplified financing plans."

The "electrical standard of living" program, as described by Mr. Snyder, will consist of a number of local activities each sponsored by an electric service company in its own territory. Participation by the public will be of two kinds.

Those building or modernizing a home, work on which was begun after February 1, 1937, and which will be completed some time within the period of August 15, 1937, to October 31, 1938, will be invited to submit plans, specifications, and photographs to their local sponsor. These will be judged by an impartial jury and rated according to the way they best realize the following ten specifications: good location and architecture; sound construction and skilled labor; quality materials and equipment; landscaping and interior decorating; sound financing; new materials; insulation and sound deadening; heating and air conditioning; plumbing and sanitation; electrification.

Awards for the best entries will be made by the sponsoring electric service company. In addition to these, various manufacturers have already indicated that they will award special prizes. In this connection, General Electric will give 20 prizes of $1,000 each for the

(*Continued on page* 400)

What the Utilities Are Doing to Promote Air Conditioning

The information contained in this study was developed through a Survey made on behalf of the Promotional Division, Air Conditioning Committee, E.E.I. (W. G. Moore, Texas Power and Light Company, Chairman):

The Questionnaire of the Committee was developed and summarized by Anson D. Marston, Kansas City Power and Light Company, who was Chairman of a Special Survey Committee.

The BULLETIN *is used as a means of reporting this information to those who gave helpful assistance through their answers, and also to reach all groups concerned with the growth of air conditioning load.*

NOW that air conditioning has taken its place as a major item of electric utility load, companies the country over are taking an intense interest in the methods used for promotion. Such questions as "Where shall we get salespeople, and how shall we train them?", "What part of the air conditioning business shall we emphasize?", "Shall we sell any equipment?" are being asked. Answers must and will be found.

Many companies have been active in this field for several years. These companies have acquired a store of valuable experience, but they are scrutinizing their promotional methods to see where and how they can be improved. To other companies there is coming a growing conviction that the time has come for them to "come on in—the water's fine."

As an aid to this critical study of the methods producing best results the Air Conditioning Committee (Promotional Division) sought through a questionnaire to bring out answers to the questions which have been puzzling executives charged with responsibility for air conditioning promotion.

The replies to this questionnaire were most satisfactory. Altogether 104 utilities, located in 40 states and representing all parts of the country, supplied information. Of these, all but eight are active in the promotion of air conditioning.

These answers reveal a story of outstanding achievements in this field. A careful study of them shows the effect which differing climatic and economic conditions have on promotional methods, but there are many broad points on which there is general agreement. These may be brought out by the following statements of methods used by *Any Company,* located *Anywhere* in the U. S. A. The effect of location, and the extent of agreement as to methods, will be brought out in this brief discussion of the individual questions asked.

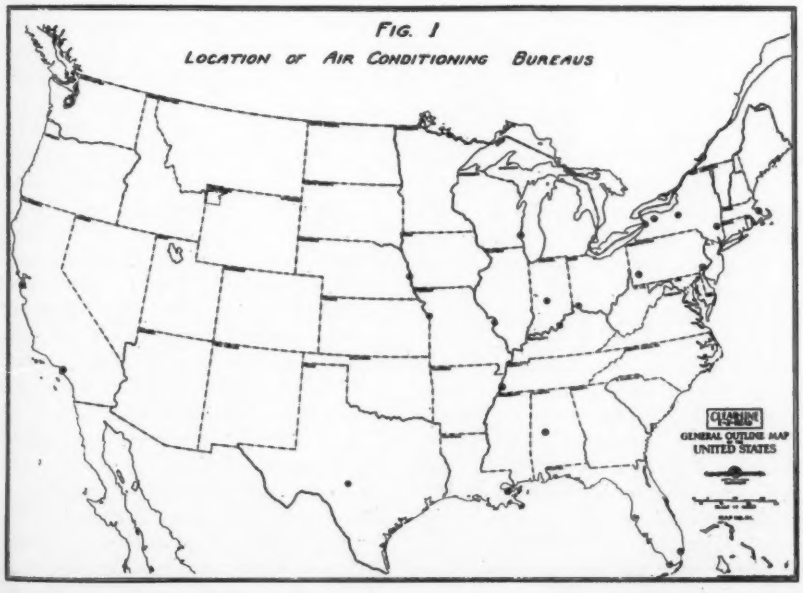


FIG. 1
LOCATION OF AIR CONDITIONING BUREAUS

The *Any Company* is active in the promotion of year-round air conditioning, room cooling, and attic ventilation. Generally speaking, primary emphasis is placed on year-round air conditioning. Salespeople are taken from inside present employee organizations, and usually given special training in which manufacturers' help plays an important part. Prospects are obtained primarily through a combination of advertising and direct solicitation.

The *Any Company* does not sell air conditioning equipment; consequently cooperation with dealers and manufacturers is a major problem receiving a great deal of thought and attention. Wherever the local conditions justify one, an Air Conditioning Bureau or Council has been organized, with the utility an active member. Advertising efforts are concentrated mostly on newspaper and direct mail.

What the Questionnaire Tells Us

While these statements are generally true of those air conditioning departments producing best results, they do not contain any allowance for the effect of local conditions. Here a detailed study of the replies to each question is needed.

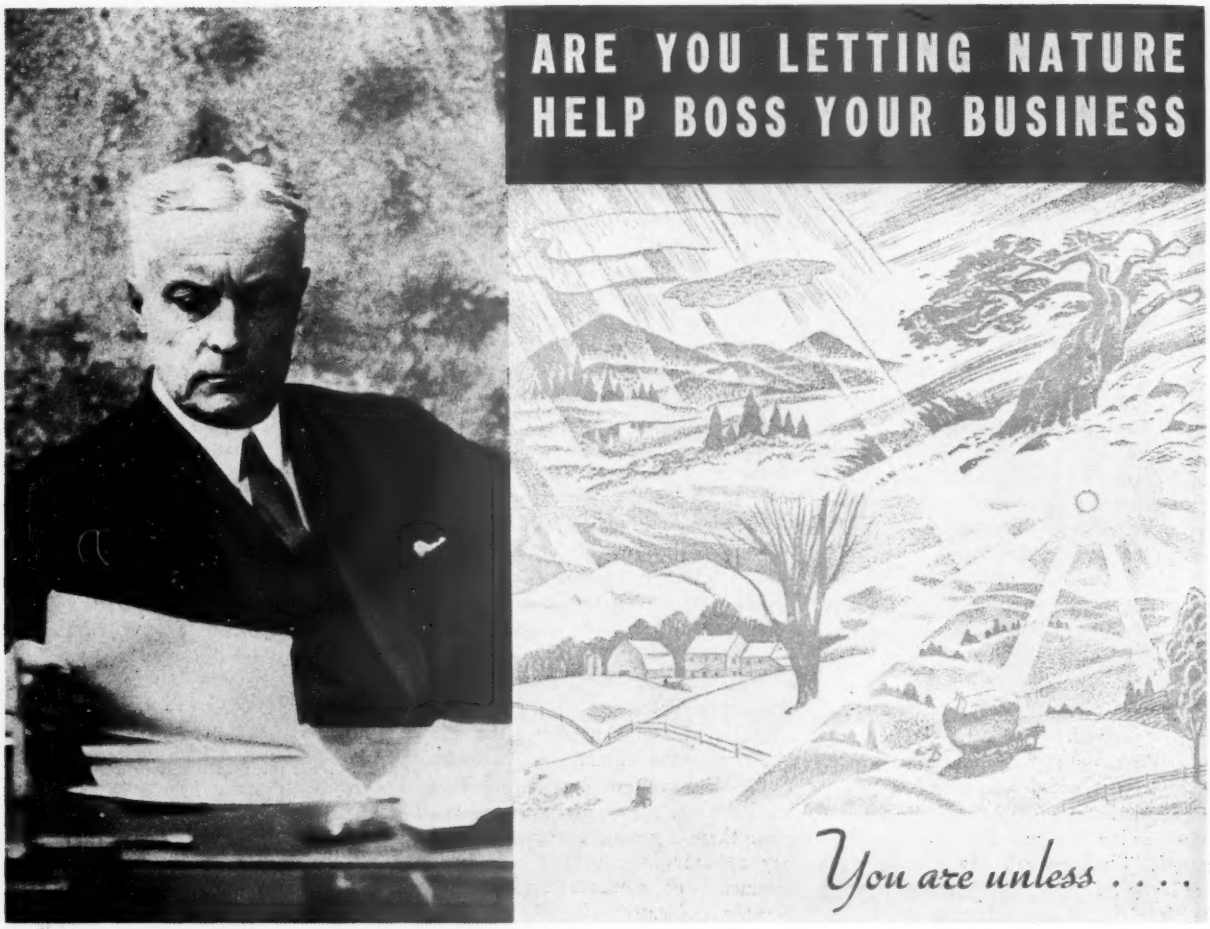
1. *"Are you selecting salesepople from inside or without present employee organization?"*

This question was answered by a total of 90 companies, of which 83 have special air conditioning salesmen. Seventy-two of these companies got their salespeople from inside their present employee organization. Three depend entirely on outside sources for their salespeople and 8 use both sources. In the answers to this question, there were no pronounced variations in the different parts of the country.

In contrast to the general preference for salespeople selected from within the organization, one company getting men from both sources says, "Best success with men already trained in air conditioning."

2. *"What are your training methods?"*

Significant in the answers to this question is the part played by manufacturers. Of the 82 companies answering this question, all but 13 are furnishing



Cover of a 12 x 9 inch booklet of the Philadelphia Electric Company promoting commercial air conditioning. On the next page are reproductions of four pages of the booklet, and a reproduction of two pages of "The Air Conditioner," periodical published by the Air Conditioning Council of Kansas City

some form of training to salespeople. Thirty-three have sent salespeople to manufacturers' schools and an additional 17 are depending on help given by manufacturers. Thirty companies are conducting training programs within their organization, while 10 simply encourage the employee to get his own training through individual study.

Among the geographical trends noticed in these answers, there is a significant dependence upon night schools and correspondence schools by companies in the New England States. In the Middle Atlantic States a large proportion of the companies appear to be conducting training programs of their own, although there is a natural use also of manufacturers' schools. Oddly enough the West South Central States appear to depend primarily upon manufacturers' schools, although they are generally far removed from most air conditioning factories.

3. *"To what extent will you promote in 1937?*

(a) *"Year-Round Air Conditioning?"*

This question was answered by 102 companies, of which all but 12 are showing some activity in the promotion of year-round air conditioning. Fifty-eight companies are very active in this field, while the others are moderately active. No pronounced geographical trends are evident in the answers to this question.

(b) *"Room Cooling?"*

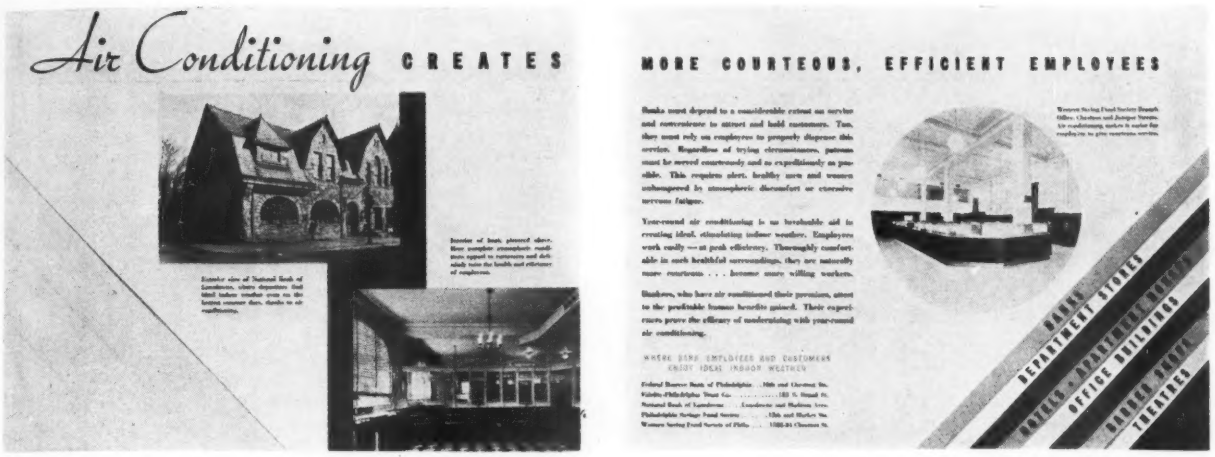
This question was answered by 101 companies, of which 81 are showing some activity. Forty-six are very active in the promotion of room cooling, while the rest are moderately active. Although there appeared to be no marked geographical trends in the answers to this question, interest in room coolers lagged in the Pacific, Mountain, and New England districts.

(c) *"Attic Ventilation?"*

Of the 102 companies answering this question, 70 are promoting attic ventilation. Forty-two are very active, while the rest are moderately active. The influence of varied climatic conditions is clearly apparent in the answers to this question. In the New England, Mountain, and Pacific districts there is little interest in attic ventilation. In the East South Central and West South Central districts there is more effort devoted to attic ventilation than to year-round air conditioning or to room coolers. In the West North Central and South Atlantic districts the interest is about even in all three fields of activity.

4. *"On which group will you place greatest emphasis?"*

Geographical trends in the answers to this question have been discussed under 3 (c). Altogether a total of 87 companies answered, with 56 emphasizing year-round air conditioning, 22 empha-


Air Conditioning CREATES
MORE COURTEOUS, EFFICIENT EMPLOYEES
Banks must depend to a considerable extent on service and convenience to attract and hold customers. Tan, they must rely on employees to properly dispense this service. Regardless of trying circumstances, patrons must be served courteously and as expeditiously as possible. This requires alert, healthy men and women unhampered by atmospheric discomfort or excessive nervous fatigue.
Year-round air conditioning is an invaluable aid in creating ideal, stimulating indoor weather. Employees work easily — at peak efficiency. Thoroughly comfortable in such healthful surroundings, they are naturally more courteous . . . become more willing workers.
Bankers, who have air conditioned their premises, attest to the profitable business benefits gained. Their experiences prove the efficacy of modernizing with year-round air conditioning.
WHERE BANK EMPLOYEES AND CUSTOMERS ENJOY IDEAL INDOOR WEATHER
Federal Reserve Bank of Philadelphia . . . 10th and Chestnut Sts.
Fidelity-Philadelphia Trust Co. . . . 135 S. Broad St.
National Bank of Lansdowne . . . Lansdowne and Stations Area
Philadelphia Savings Fund Society . . . 12th and Market Sts.
Western Saving Fund Society of Phila. . . . 1700-24 Chestnut St.
BANKS
DEPARTMENT STORES
OFFICE BUILDINGS
BARBER SHOPS
THEATRES

Air Conditioning INSPIRES
THESE OFFICES OFFER WORKERS MADE-TO-ORDER WEATHER
BETTER WORKMANSHIP - APPEALS TO TENANTS
Perpetual clean, fresh air; No drafts . . . no stuffiness! Correct temperature — a constant circulation of cool air, free of excessive humidity in the summer . . . of warm air automatically supplied with necessary humidity in the winter! That is the ideal condition workers enjoy in year-round air conditioned offices. Lucky are they. Equally lucky are their employers. Why? Because people so protected from the hitherto ill Nature work easier, better and more quickly. In this bracing and quiet atmosphere they succumb much less readily to minor ills. Absences and nervous fatigue decrease. Efficiency increases.
TENANTS, TAKE NOTE
Given a choice of renting air conditioned quarters and those not, prospective tenants definitely prefer a building offering this modern comfort. This is evidenced in the success enjoyed by the management of the Philadelphia Saving Fund Society building, 12th and Market Streets. Air conditioning not only attracts tenants . . . but holds them. A highly profitable investment that becomes steadily more necessary!
OFFICE BUILDINGS
BARBER SHOPS
THEATRES

THE AIR CONDITIONER
Official publication of the
AIR CONDITIONING COUNCIL
OF KANSAS CITY
VOL. IV. JUNE 1937 No. 7
Published twice a month during the winter and summer and once a month during the fall and winter.
To give the public a complete and correct understanding of Air Conditioning as it affects home, business, industrial and professional life.
CHAS. W. STANSBOUGH
Editor
ARDON D. MARSTON
Associate Editor
All communications should be addressed to the Editor, Room 847, Power & Light Building, 14th West 10th St., Kansas City, Mo.

That's Living!

When you can sit, by dawn, or more almost in perfect comfort in your home; work all day in a cool, invigorating, neutral atmosphere at the office—when the temperature outdoors registers a hundred degrees—plus . . .

When you can go about your daily tasks, greet clients, customers, visitors and friends at home—or in the office—with the same degree of cordiality, the same quick mental adjustment to the occasion . . .

When you can be as perfect a host or comelike when the world, dewsbling, steps all unbearable heat out of doors (and indoors in other places) in making life miserable for other people . . .

THAT'S LIVING!

There's only one way you can accomplish it — install Air Conditioning, both in your home and in your office.

Why not do it — now, for the summer? Why go through another season of downright torture? Why subject yourself, your family, your employees, your clients and customers to the miseries of hot weather? . . .

Why miss the untold advantages of cool comfort for all—when, for a comparatively small outlay, you can provide Air Conditioning—the greatest boon to humanity yet developed? . . .

AND REALLY LIVE!

Air Conditioning Rumors Cincinnati's Smokes

"A $125,000 reptile house air conditioned and furnished to suit some 30 varieties of snakes, was formally opened at the Cincinnati Zoo, May 2. This is the first time the zoo has had a permanent place to exhibit snakes, according to James A. Reilly, zoo president."—Air Conditioning & Refrigeration News.

(Continued from page 1)

Automatic Control

Automatic control of the system in the summertime has been accomplished by means of a room thermostat in the conditioned area controlling the compressor and evaporative condenser. This system is arranged for continuous circulation of air both summer and winter. Automatic control in the wintertime consists of a thermostat in the discharge air duct controlling face and by-pass dampers across the heating coil. A limit stat is installed adjacent to the heating coil which does not permit the fan to run unless there is sufficient heat in the heating coil to properly heat the air entering the room.

The air conditioning unit, duct work, fan, humidity equipment and heating equipment was installed last fall, and has been in operation during the past winter. The compressor and evaporative condenser was added this spring. All units where exposed in the general and private offices have been covered with metal lath and plaster so as to produce a neat appearance.

"It's in the Air"

Air Conditioning Lowers Time Lost by Employees Illness 41% in Omaha Office

"Installation of air conditioning equipment in the office of the Mooseheart Lodge of Woodmen of the World here has resulted in decided improvement among employees in time lost on account of sickness," reports V. E. Fahrney, Secretary.

"Comparison of employee absences because of illness during five months of 1936, after air conditioning had been installed, showed a 41% rise in efficiency over the same period of 1935," Mr. Fahrney states.

During July, efficiency reached its highest point, improvement being almost 50% over the same month the year before.

"Instances of employees absences because of illness during five months of 1936, after air conditioning had been installed, showed a 41% rise in efficiency over the same period of 1935," Mr. Fahrney states.

Dentists Report Air Conditioning Relieves Strain and Builds Practice

"Reflection that the American Dental Profession is practically unanimous in its approval of air conditioned offices as a means to lessening operating strains of the dentist himself and aiding the comfort of his patients is found in returns from a recent questionnaire sent to a representative cross-section of the profession by Oral Hygiene Publications.

"Unanimously affirmative replies were obtained to the question 'Does

(Continued on page 6, col. 2)

A Year-Round Air Conditioning System for an Existing Residence

When contemplating the installation of an air conditioning system for a residence that was built without regard to the present concept of year-round air conditioning, three major problems confront both the owner and the engineer. First, the obtaining of desired results, namely, comfort

View in corner of living room of a Kansas City home—note Air Conditioning Grille in wall above bookcabinet.

This South Component Air Conditioning Unit is located across this home.

under all conditions of outside weather. Second, the keeping of operating costs down to a minimum. Third, interference of appearance of the installation.

The Kansas City residence described in this article presented the following problems:

1. The heating system was of the hot water type, and consequently without any duct work.

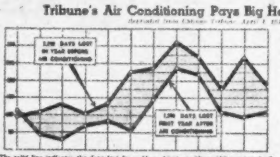
2. The upstairs partitions did not coincide with those downstairs, rendering it extremely difficult to install duct work.

3. The third floor was finished and used for servants' quarters, thereby precluding the use of the third floor space for duct work.

In consequence, a central duct system for the entire home was out of the question. It was decided to use a unit system for the second floor. Due to the fact that the interior decoration and other arrangements of the house on the first floor did not permit the use of concealed units, it was desirable to use a central duct system for the first floor.

Fortunately the house was located in Kansas City, where dehumidification is not necessary, since the outside humidity is usually low enough to provide adequate comfort conditions. Therefore, the problem of dehumidification was eliminated.

Tribune's Air Conditioning Pays Big Health Dividends



The solid line indicates the days lost by Tribune employees, installation of the air conditioning system. The broken line below illustrates the days lost after the system was placed in use. The figures represent employees, regardless of time lost by employees.

Respiratory Illness Decreased Among Employees

How air conditioning in Tribune Tower has armed Tribune employees against colds, influenza, and kindred infections was disclosed yesterday. The survey reveals that air conditioning pays solid health dividends.

The survey was begun in May, 1935, exactly twelve months before the air conditioning unit was installed in the Tower. At that time, according to the reports of J. F. Kreutzer, head of the Tribune Employees' Benefit Plan department, there was an average of 2.50 persons on the Tribune pay roll each month.

Miss 2,220 Work Days

During the twelve months from May, 1935, to May, 1936, a total of 475 persons were compelled by various respiratory diseases to miss one or more days of work. These 475 employees missed a total of 2,220 days of work, an average of almost five days each.

On May 10, 1936, the air conditioning system for the entire Tribune Tower was placed in operation. Beginning that day, all Tribune employees who worked in the Tower began breathing washed, humidified, and properly heated air. The results became apparent immediately.

Despite the fact that for the year of May, 1936, through April, 1937, The Tribune employed an average of 2,000 persons a month, only 345 became ill enough to miss a day of work, and these present missed only 1,220 days, an average of slightly more than three and a half days a person.

Stated in another way 22 per cent of the total number of employees during the year May 1, 1935, through April 30, 1936, became ill enough to remain away from their jobs one or more days. For the subsequent twelve months the percentage dropped to 13 per cent of the total number of employees.

During the remainder of 1937, from May 1 through Dec. 31, only 104 persons missed days of work, although the average number of employees in those months was 2,600.

Even in Epidemic Year

In the epidemic year 1936, when influenza was rampant, only 971 Tribune employees out of an average of 2,000 on the pay roll were found to stay home because of respiratory illnesses, Kreutzer's records show.

Dr. Irving S. Cutter, dean of the Northwestern university medical school and The Tribune's health adviser, said yesterday that the excellent health record of Tribune workers during the last two years was undoubtedly due in a large measure to air conditioning at the Tower.

The two figures above represent the 2,150 employees who worked in the Tribune before installation of the air system, and for the year after. The figures at center below represent the number of days lost because of illness before and after use of the air conditioning system. Regardless of employees, the loss of time was cut 50 per cent under air conditioning.

Installations in Kansas City Break All Records!

Kansas City has become air conditioning conscious and is buying it for 1937 "on the dotted line"—as the accompanying Installation List shows. Installations reported up to and including May 31st total approximately 2,100 horsepower as compared with 2,000 horsepower for the entire year of 1936. Other installations now on order or partly completed will raise the figure for this year to about 3,500 horsepower.

Practically all of these installations have been designed in accordance with standards set up by the Air Conditioning Council of Kansas City, thereby assuring satisfaction and comfort.

Air conditioning has passed the guessing stage. Refrigerants are being made and will continue to be made but there is no need to feel doubtful about the results of an installation by contracting to a competent consulting engineer or architect and reputable manufacturers or their distributors and contractors.

Installation list, January to May, incl., 1937.

General Offices
Black & Veatch
Brown & Lee
Bryant Building
City Hall
Commerce Building
Community State Bank
Ethyl Gasoline Corp.
Fairfax Building
Harris Upham
James C. Batcheldor
Interstate Securities
Kruger Gen. & Baking Co.
Nallin Engineering Corp.
Orear-Leslie Building
Paramount Pictures
Phillips Petroleum
Postal Life & Casualty
Professional Building
Railway Ticket Office
Ralston Purina
Standard Brands
Skelly Oil Co.
20th Century Fox
21 W. 10th St. Bldg.
Upjohn Company
Western Casualty & Surety Co.
Whitaker Battery Supply Co.
Frei Wolferman

Hotels and Restaurants
Beaman's
Blue Bird
Country Club Plaza Grille
Fowler's Lunch
Hafner's Judy (Otto Weitman)
Keithley's
J. H. McCombs
Muehlebach Hotel
Frank Palizzo
Pickwick Hotel
Pompeii
President Hotel
Ray's Lunch
Saylor's
Sidney's (Kingsberg)
Southern Mansion
Thrifty Lunch
Vettke Cafe (Pattie)
Plaza Royale

Miscellaneous
Brookside Theater
Eastman Kodak
1427 Club

(Continued on page 8, col. 1)

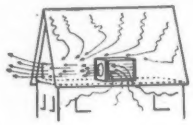
MAKE YOUR HOME *a Refuge*

from Texas Summer Heat

WITH A TEXAS HOME COOLING SYSTEM in your house you are doubly glad to get home after a business day because you can enjoy the companionship of loved ones in a veritable refuge from the hot summer heat!

This amazingly inexpensive cooling system drives the hot, stagnant air out of the house and attic and brings in the cool of the evening. It assures comfort and a good night's rest for every member of the family . . . And you can laugh at the sun if you sleep well at night!

SEE HOW IT WORKS



Adapted for either cottages or two-story homes. Any good mechanic can install it! Investigate today. Particulars gladly given. Let us show you a successful installation in your own neighborhood.

TEXAS POWER & LIGHT COMPANY

102° HERE; 8TH TORRID DAY
NO RELIEF IN SIGH AS CITY SWELTERS 'N BOILING
Western Heat Bars Rain; Relief Is Due Wednesday
240 DIE IN HEAT WAVE; RELIEF
CHICAGO TO SWELTER 2 DAYS
HOPE MELTS
New Hot Week-End Ahead for Midwest
HEAT SMASHES
No Relief Yet
HEAT STAYS ON,
CITY BAKES 24 HOURS LONGER
RECORD; 72 DIE
HOW HIGH IS UP? 101
Predicted Rains Fail to Arrive
Midwest Till 72; Thousands Jam Beaches
102° HEAT!
Heat Hits 101;
Heat Sets New Records Over Half of Nation
101 Temperature for 1936 Record
SIZZLING
Heat Stays in Spite of Showers
Federal Help Is Prepared to Offset Drouth
Record Forbids Wave Moves On
MERCURY HI
RECORD; 7
Plan now FOR SUMMER COMFORT with ELECTRIC AIR CONDITIONING
The heat wave always comes! Read the newspaper headlines of last July. It may be freezing now, but summer is on the way with its sizzling, scorching days
● Enjoy cool comfort when hot weather comes again. Be ready with electric air conditioning in your store, restaurant, shop or office.
Electric air conditioning will mean increased summer business . . . greater profits . . . hot weather comfort for yourself, your employes and your customers.
Now is the time to plan for the installation of air conditioning equipment. Don't delay—the rush is beginning.
Call RANdolph 1200, Local 168, today and ask one of our air conditioning engineers to make a survey of your place of business and give you recommendations as to the type of equipment most practical for your needs as well as estimates of the cost of installation and operation.
COMMONWEALTH EDISON COMPANY
Air Conditioning Division, RANdolph 1200, Local 168
72 WEST ADAMS STREET
NO RELIEF FOR CHICAGO IS DUE TILL TOMORROW
CITY BROILS IN 3D DAY OF HEAT
HOT AGAIN TODAY
Mercury Expected to Reach 90
LAKE BREEZES GIVE WAY TO TORRID WAVE
City Faces Torrid Week-End; Rains to Break Drought
MERCURY HITS 94
LAKE FAILS TO CURB HEAT; NO RELIEF OVER WEEK-END
100 TODAY
105 ON WAY
TOLL MOUNTS TO 306 WITH 28 DYING HERE
RECORD BROKEN
HEAT WAVE HERE
CHICAGO TOLL RISES TO 201; RAIN ON WAY!
Predict 100 Degrees in City
ID DAY
Chase Heat
Heat Stays for Week-End; Rain to End N. W. Drought
CITY IS DUE TO SWELTER
HEAT HITS 101
HEAT NEAR E
NO RELIEF SEEN
Another Torrid Week-End Ahead for Middle West
Heat Will 'End Late Today' Rain Sweeping In From West
94 Heat Scorche
Lake Sands a Refuge as Hot Wave Persist
CITY TO SWELTER INDEFINITELY

Air conditioning advertisements of Texas Power & Light Company and Commonwealth Edison Company

sizing room coolers, and 29 pushing attic ventilation. A number of companies are concentrating on two classifications, thereby causing some duplication of answers.

5. *"What is your method of obtaining prospects?"*

As would be expected, the answers to this question represent a wide variety of methods. Direct soliciting and advertising are the most popular sources, with 68 out of 81 companies using soliciting and 37 using advertising. Most of the companies doing soliciting make extensive use of their existing power sales organizations.

It is significant that many of the companies having extensive advertising programs fail to mention advertising as a method of obtaining prospects. Apparently they do not consider it particularly valuable in this regard.

A number of other sources of prospects come in for mention. Employee leads and new building reports were mentioned by eleven and ten companies respectively. Several companies make analysis of customer accounts. Others depend on outside sources, such as dealers and architects.

6. *"Do you sell air conditioning equipment of any kind?"*

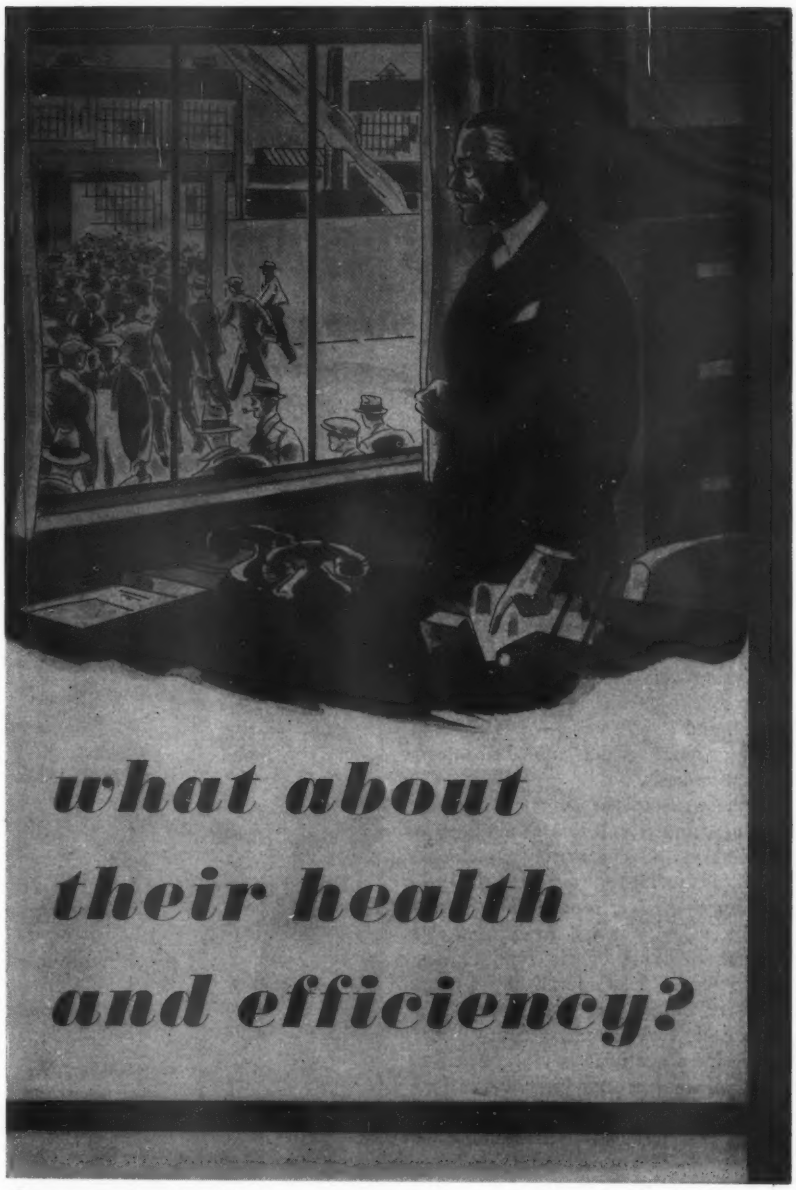
A large majority of the 96 companies answering this question said "No." Altogether, 65 companies said they do not sell any equipment. Only 13 answered "Yes" without qualifications. Of the remainder, most companies confine their sales to attic fans or room coolers or both.

Thus it may be said that most utilities sell little or no air conditioning equipment. Some sell in small towns or in portions of their territory not served by dealers, but in general there is a desire to leave selling to dealers and distributors wherever these outlets are equipped to furnish adequate service.

In the New England and Pacific districts the utilities are unanimous in their refusal to sell any equipment. In the West North Central and West South Central sections the only things sold are attic fans and room coolers. The South Atlantic section shows the largest proportion of equipment sales, with 4 out of 11 utilities selling complete lines, while two sell attic fans or room coolers only.

7. *"What methods do you employ to cooperate with manufacturers and dealers in air conditioning equipment?"*

Here there is such a wide variety of answers that no direct tabulation is feasible. There was emphasis on the importance of dealer cooperation as a major factor in the successful promotion of air conditioning.



Cover of Air Conditioning Promotional Booklet of Philadelphia Electric Company.

Practically all companies not doing direct selling turn prospects over to air conditioning dealers. Many render assistance in actual selling. Many have representatives whose chief duty is the maintenance of dealer cooperation. Some few render engineering assistance to dealers.

Some few companies advertise in cooperation with dealers. One company pays dealers a bonus of $1.00 per horsepower connected.

Another method of assistance consists of displaying equipment for dealers. St. Louis has a fine example of such exhibits —space is furnished for any reputable dealer who desires to install and operate a sample piece of equipment.

One of the most effective methods of cooperation is the formation of a local Air Conditioning Bureau, as discussed in Question 8.

8. *"Have you a Local Air Conditioning Bureau or other organization for promotion?"*

The replies to this question indicate the widespread interest existing in Air Conditioning Bureaus. In practically every large population center one has

Air conditioning advertisements of Texas Power & Light Company and Commonwealth Edison Company

been organized or efforts have been made to start one. In several cities this function is covered by a special division of the Electric Association.

Altogether the existence of 21 Bureaus, participated in by 27 utilities, was reported. The location of these Bureaus is indicated on the map shown in Figure 1. It will be noticed that there are none in the Mountain district, and that the South Atlantic, West South Central, and Pacific districts have only one or two each. In New England the Air Conditioning Bureau of Boston is participated in by three operating utilities.

9. *"What advertising and publicity methods are you using?"*

Direct by mail and newspaper advertising ran "neck and neck" in the race for favor, with 47 utilities reporting the use of direct mail and 44 using newspapers. Altogether 84 companies answered this question, with 24 of these reporting that they do no advertising.

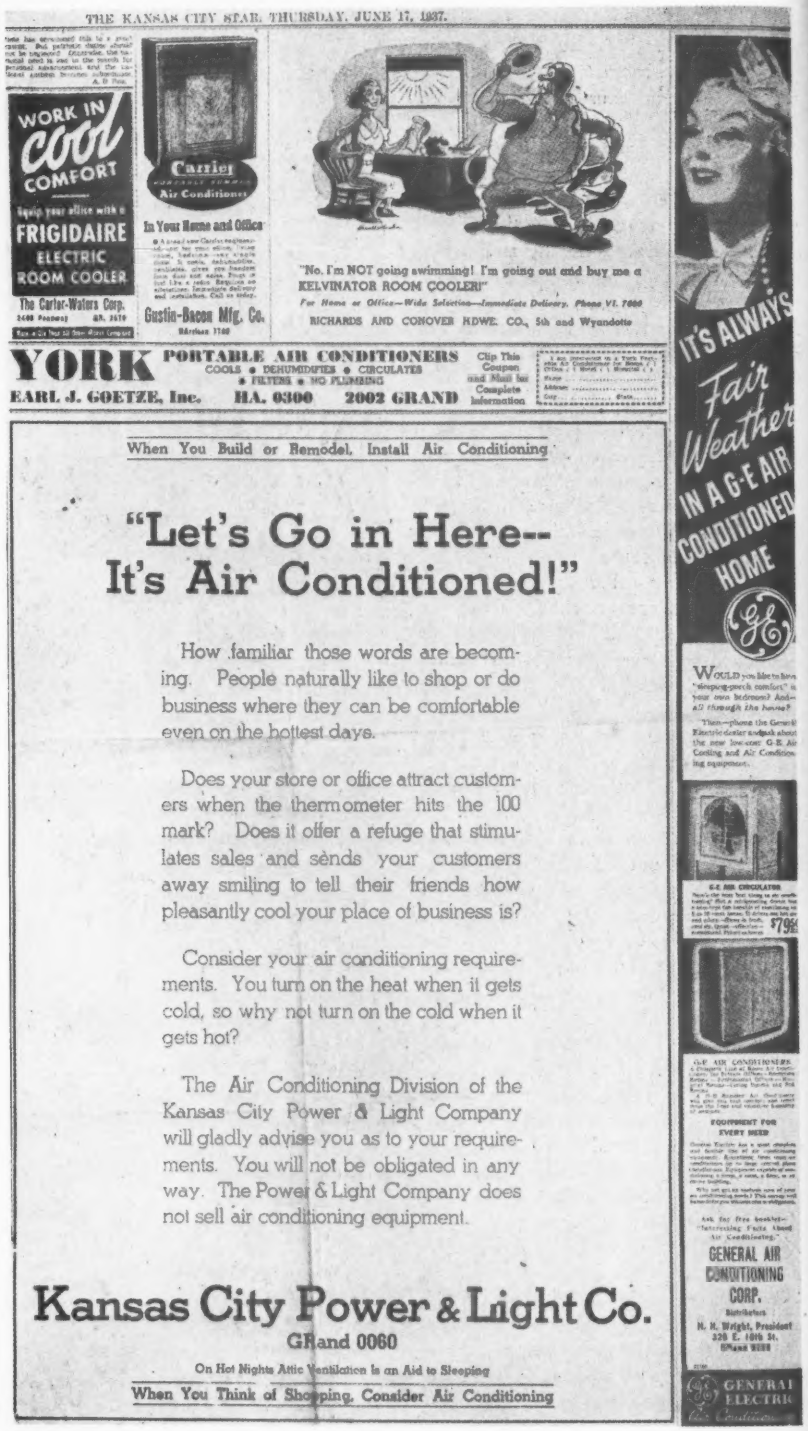
In the West South Central section 5 utilities use billboards, out of a total of 8 using this method in the entire country. Three cities—Kansas City, Omaha, and Los Angeles—have air conditioning news media published on a cooperative basis.

In their newspaper advertising many companies find it valuable to arrange so that dealers and contractors can insert "tie-in" ads in cooperation with the utility company's advertising. Thus a utility which does not sell equipment can advertise the idea of air conditioning, and the dealers can insert small ads, to go on the same page, giving their own sales message. A sample of this type of cooperative advertising is reproduced.

A wealth of outstanding sample material was submitted by companies answering this question. Unfortunately it is impossible to reproduce more than a few typical advertisements.

Most of the material submitted follows closely the advertising themes recommended by the EEI Air Conditioning Committee in collaboration with the Air Conditioning Manufacturers' Association. Utilities realize the value of an advertising program tied in closely to that of the manufacturers.

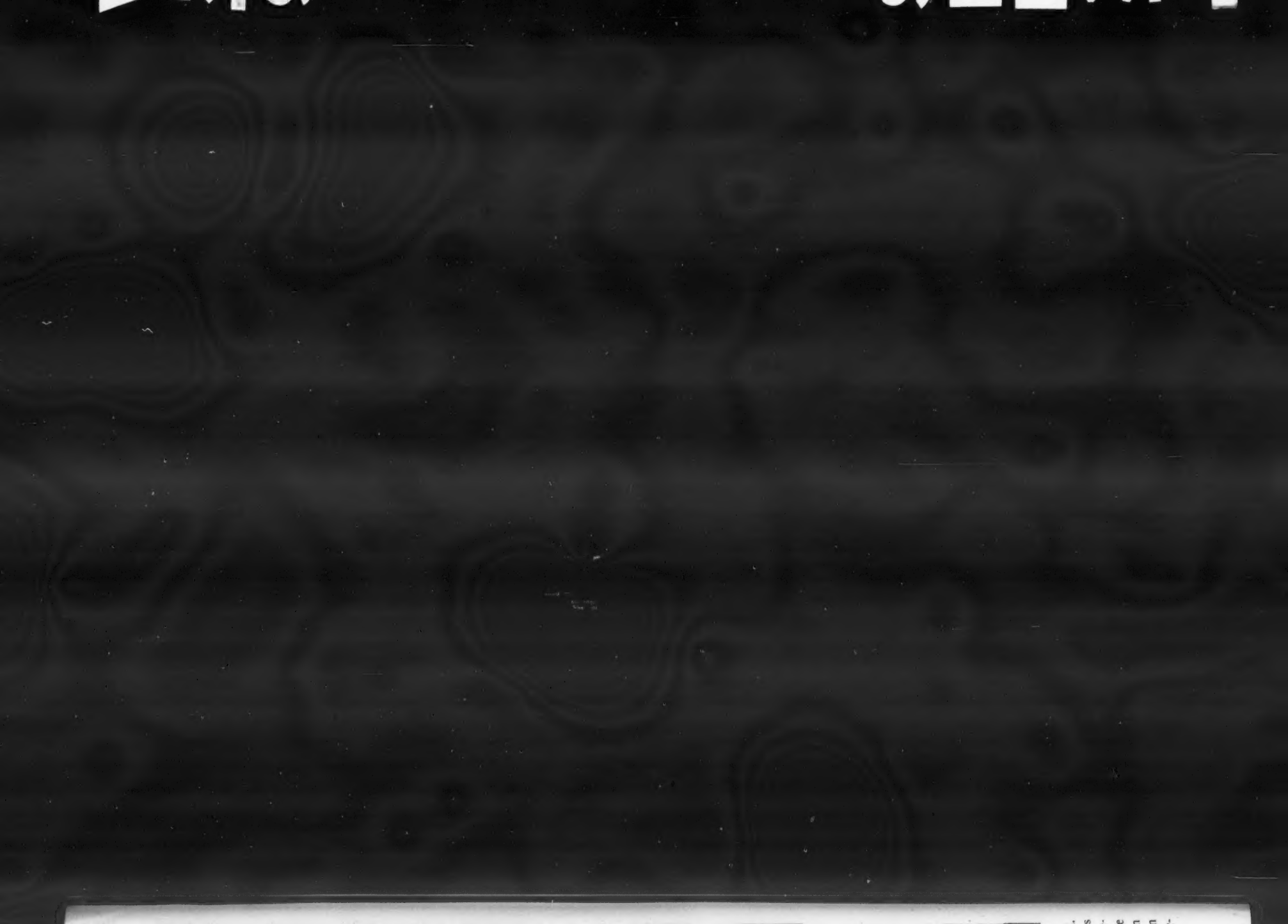
Many excellent mailing pieces were submitted. While space prohibits mention of them all, the New Orleans Public Service, Inc., has a good representative folder on residential air conditioning. The Philadelphia Electric Company has the most comprehensive piece on commercial air conditioning, and the only piece submitted on industrial air conditioning.


THE KANSAS CITY STAR, THURSDAY, JUNE 17, 1937.
WORK IN COOL COMFORT
Equip your office with a
FRIGIDAIRE
ELECTRIC
ROOM COOLER
The Carter-Waters Corp.
Carrier
Air Conditioner
In Your Home and Office
Gustin-Bacon Mfg. Co.
"No, I'm NOT going swimming! I'm going out and buy me a KELVINATOR ROOM COOLER!"
For Home or Office—Wide Selection—Immediate Delivery. Phone VI. 7000
RICHARDS AND CONOVER HDWE. CO., 5th and Wyandotte
YORK
PORTABLE AIR CONDITIONERS
COOLS • DEHUMIDIFIES • CIRCULATES
• FILTERS • NO PLUMBING
EARL J. GOETZE, Inc.
HA. 0300
2002 GRAND
Clip This Coupon and Mail for Complete Information
When You Build or Remodel, Install Air Conditioning
"Let's Go in Here-- It's Air Conditioned!"
How familiar those words are becoming. People naturally like to shop or do business where they can be comfortable even on the hottest days.
Does your store or office attract customers when the thermometer hits the 100 mark? Does it offer a refuge that stimulates sales and sends your customers away smiling to tell their friends how pleasantly cool your place of business is?
Consider your air conditioning requirements. You turn on the heat when it gets cold, so why not turn on the cold when it gets hot?
The Air Conditioning Division of the Kansas City Power & Light Company will gladly advise you as to your requirements. You will not be obligated in any way. The Power & Light Company does not sell air conditioning equipment.
Kansas City Power & Light Co.
GRand 0060
On Hot Nights Attic Ventilation is an Aid to Sleeping
When You Think of Shopping, Consider Air Conditioning
IT'S ALWAYS Fair Weather IN A G-E AIR CONDITIONED HOME
GENERAL AIR CONDITIONING CORP.
GENERAL ELECTRIC

10. *"Have you a slogan to suggest for our promotion?"*

Several serviceable slogans were presented, "Air Conditioning—a Year-'Round Necessity"—"Better Air Means Better Business"—"Air Conditioning for Health and Profit"—these and many others deserve mention. The use of the word *Electric* was emphasized.

The Committee wishes to express its gratitude for the hearty cooperation received from reporting companies. The response to this questionnaire has been gratifying indeed and the information gained should help all interested materially in serving this new load.



The Rural Electrification Program of Niagara, Lockport and Ontario Power Company

Winner of the Thomas W. Martin Award in 1937

An abstract of the Company's Exhibit entered for the Martin Award

NIAGARA, Lockport and Ontario Power Company serves a territory of 4925 square miles in Western New York which is predominantly agricultural, covering all of Orleans and Genesee Counties, practically all of Niagara, Chautauqua and Cattaraugus Counties, and large portions of Erie, Monroe, Allegany, Livingston, Wyoming and Ontario Counties.

Within this area are found all types of farming common to the State of New York, including market gardening, dairy, poultry, fruit, grape and crop farms. Market gardening is confined mainly to small but intensely cultivated land near Buffalo, Niagara Falls and Rochester, and to muck lands in Genesee, Orleans and Livingston Counties. Grape culture is found along the shore of Lake Erie and in Niagara County. Fruit is found in Niagara, Orleans and Monroe Counties and forms the chief farming industry of the Lake Ontario shore region, although poultry raising is on the increase here as well as in all other parts of the territory and is one of the principal agricultural activities of the entire region. Dairying is a major farm industry in Cattaraugus, Chautauqua, Erie, Allegany, Wyoming, Genesee and Livingston Counties, while in the last four counties crop and general farming are important also.

According to the U. S. Census of 1930, the company's franchise area included 23,261 farms. According to the company's records, 13,126 farms in these areas were connected to its lines on December 31, 1936. In addition, service was available to 1700 farms along the existing rural lines but which were not connected. The census definition of a farm is used in each case, but the enumeration is made by different individuals. In addition to 13,126 farms, 28,294 non-farm rural customers were served by 3,735 miles of rural lines at the end of 1936. The definition of "rural" is territory outside of cities or incorporated villages of 2500 or more inhabitants. It includes, however, hamlets and villages of less than 2500 population.

Agricultural Advancement Due to Use of Electricity

The Rural Service Department which has been maintained by the company since 1929 has introduced many new uses of electricity in agriculture which have a tendency to lower the cost of production, reduce labor-hours, or increase farm income. Among these applications may be mentioned:

Portable motor drive for farm machinery
Electric milk cooling
Electric brooding
Soil heating
Soil pasteurizing
Dairy utensil sterilizing.

The portable 5 and 7½ h.p. motor has found its greatest application on those farms where one or two men handle all of the farm work and do not exchange labor with neighbors or where a tractor, if used at all, is needed for field work at the time that the silo must be filled. With one or two men filling silo, each loads his own wagon, starts the motor when ready to cut corn, and shuts it off when the load has been run through the cutter. No one is needed to attend to the motor as is necessary when tractor power is used. The labor of feeding a crew is eliminated and other farm work is not neglected over a week or more exchanging labor. By spreading the silo filling job over several days, more corn is put in the silo, and at much less expense than when the job is done in one day. By using the motor to drive the hay hoist, one team and one man are eliminated or released for field work and the filling of the mow is accomplished in less time. The feed grinder can be arranged for gravity feeding when driven by this motor, thus permitting grinding to be done without one man having to shovel grain into the hopper of a large mill while another operates the tractor to drive it.

The application of the electric refrigeration compressor to submerged-can milk cooling was developed in New York State and is being used extensively. This method, which eliminates the cutting and storage of ice and which accomplishes much better cooling than is possible with well water, has enabled many farmers who ship milk to New York City to raise their milk from the Grade B classifications to Grade A, thus securing a better price. Even in the other milk markets where such a premium is not available, the better quality of milk produced has prevented the rejection of milk, especially in summer months, due to improper cooling.

The introduction of electric brooding was difficult, due to skepticism on the part of farmers towards cold-room brooding, but with the experience gained on the first installations, plus the results of the excellent experimental work conducted at the New York State College of Agriculture, the use of electric brooders is increasing rapidly. The electric brooder eliminates the fire hazard of fuel burning brooders, the handling of fuel and ashes and overheating of brooder houses on warm days and burned out fires on windy nights. It permits the poultryman to operate more brooders with no increase in labor, and turns out better birds, with finer feather texture and less susceptibility to chilling when put out on range.

Practically all the market gardeners in the territory start their seeds in greenhouses and many of these men now heat their seed beds with electric soil heating cable. It was their practice to start the greenhouse heating system the first week in February, heating the entire house to 75 degrees just to warm up the seed bed. With electric soil heating they now start the seed bed several days later than formerly, and need not start the heating system for a week after that, carrying about 70 degrees of heat in the seed bed and only 55 in the house. In this way they save enough in coal to pay for the soil heating energy several times over and get better germination, sturdier seedlings and gain from three to ten days in germinating time, depending upon the plants grown.

Electric soil pasteurizing is in use to a limited extent, but gives promise of increasing due to the superior results

obtainable. For the gardener or florist whose business is small and who, consequently, grows small lots of plants, certainty of germination is most important. By reducing troubles caused by weed seeds, fungi and other harmful organisms, electric soil pasteurization has saved these men from considerable losses. It is virtually the only method of pasteurization, other than with chemicals, available to them as usually they have no sources of steam for this purpose.

Electric water heating on the dairy farm is increasing in popularity, owing to the superior results obtained in sterilizing dairy utensils when a plentiful supply of hot water is available in the milk house. It does away with the presence of fuel-operated water heaters or the necessity of carrying small quantities of hot water out from the house. Time is saved and bacteria count is lowered.

Rural Service Organization

The company is divided into six operating districts, each in charge of a District Manager. Included in the new business organization of each district is a Rural Extension Representative and a Rural Service Representative. The Rural Extension Representative receives all requests for line extensions, carries on the necessary negotiations with prospective customers, gets contracts signed, and assists the District Engineering or Construction Department in obtaining the required rights-of-way. The Rural Service Representative sells or promotes the sale of electrical farm appliances. Depending upon the organization of the individual districts, one of these representatives or an employee of the Meter Department makes wiring plans for new farm customers. In addition to these representatives, Meter Reading District Representatives or salesmen sell or promote the sale of domestic appliances, a Home Service Representative demonstrates electric cookery and assists customers in familiarizing themselves with ranges and other domestic appliances and a Home Lighting Advisor assists new and old customers to select the proper types of home lighting equipment.

General Supervision and Planning of Rural Electrification activities is carried on by the Rural Service Engineer at the Buffalo office. He assists the Rural Representatives in the Districts, takes charge of all records and statistics relating to rural electrification and supplies the field organization with up-to-date information on uses for electricity on the farm. In addition he represents the company on the Farm Electrification Council, a committee of The Empire State Gas and Electric Association, made up of rural service managers and representatives of the State College of Agriculture and the manufacturers. He also keeps in touch with the State College of Agriculture and farm organizations.

The District Managers and Rural Service Engineer report to a Vice President of the company at Buffalo.

The Rural Extension Plan

Like most utility companies serving rural territory, Niagara, Lockport and Ontario Power Company has used several rural line extension plans in the course of its existence. In the early days of its rural electrification activities, no regular plan was used. The prospective customers along each proposed line collectively guaranteed sufficient monthly revenue for a five-year period to justify the construction of the line. This was followed by the so-called Lockport plan, under which the applicants guaranteed $30.00 per month per mile revenue for five years, following which the minimum charge of $1.50 per month per customer became effective. This plan made no provision for readjustment of minimum monthly charges due to the addition of new customers after the line was placed in operation, and was abandoned in 1931 for the "Adirondack Plan" which was originated by the former Adirondack Power and Light Corporation and which, with slight modifications, came into use almost universally in the State of New York. The Adirondack Plan called for a minimum monthly charge of $2.00 per customer for the first 440 feet or less of line per customer plus 50c. per 110 feet per customer for additional construction. This amounted to approximately $24.00 per month per mile of guaranteed revenue which minimum was perpetual. In all of these plans, the customers were allowed to use the entire minimum guarantee in energy, billed at applicable rate schedules. This plan was in use in the company's territory until October 1, 1935, and under it 484.34 miles of line were built making service available to 3809 potential customers, of which 2927 signed contracts for service when the lines were built.

With the return of more favorable business conditions in 1935, and the resulting increased emphasis on rural electrification, it was felt by farmer groups and the company that some modification of the Adirondack Plan should be made in order to reach farms in more sparsely populated areas. After consultation with farm organizations and the Public Service Commission, the present rural line extension plan was evolved and was placed in operation on October 1, 1935. This plan provides, essentially, that the minimum monthly charge per customer shall be $2.00 for the first 1500 feet or less of line per customer, plus 50c. for each additional 100 feet up to a maximum of $4.50 for 2000 feet per customer. For any construction in excess of 2000 feet per customer, the customers contribute $25.00 per hundred feet of construction, thus avoiding any minimum charges in excess of $4.50 per month. At the end of five years, all minimum monthly charges in excess of $2.00 are reduced to $2.00.

Table I compares the minimum monthly charges under the Adirondack and new plans.

Under the old plan, when customers wanted to reduce their minimum monthly charges by contributing to the cost of the line, a $100 contribution was required to reduce the monthly charge by 75c. (No minimum less than $2.)

Under the new plan a contribution of $25 reduces the monthly guarantee by 50c. (No minimum less than $2.)

Just before the new line extension plan was made effective, maps were prepared of each county on U.S.G.S. quadrangles and on these maps were plotted the land classification data prepared at the New York State College of Agriculture, the existing rural distribution lines, and the suggested new extensions which appeared to be possible judging by the classification of farms made from company and college surveys.

Each operating district has a similar map. Each month this map is sent to the Buffalo office with a suitable report and the new lines are then put on the maps in the central office. In this way the maps and records are kept up to date continuously. In addition to this report, a weekly progress report is also sent in by each district and is used by the management to keep track of the general progress of the rural extension program.

Accomplishments Under the New Extension Plan

When the new program was launched on October 1, 1935, it was estimated that 1558 miles of new rural extensions would be needed to serve all good farms on land classed by the College as Class III or higher; that is, land which would probably remain permanently in agriculture. During the last quarter of 1935, 172 miles of lines were constructed for

TABLE I—COMPARISON OF MINIMUM CHARGES UNDER THE OLD AND THE NEW PLANS

OLD "ADIRONDACK" PLAN		NEW PLAN	
Length of Line Extension Per Customer	Minimum Monthly Charge	Length of Line Extension Per Customer	Minimum Monthly Charge
			$2.00
			2.00
			2.00
			2.00
		UP TO 1500′	2.00
			2.00
			2.00
			2.00
			2.00
			2.00
		1501′ to 1600′	2.50
		1601′ to 1700′	3.00
		1701′ to 1800′	3.50
		1801′ to 1900′	4.00
		1901′ to 2000′	4.50
			*
			*
		ABOVE 2000′	*
			*
			*
			*
Up to 495′	$2.00		
496′ to 605′	2.50		
606′ to 715′	3.00		
716′ to 825′	3.50		
826′ to 935′	4.00		
936′ to 1945′	4.50		
1046′ to 1155′	5.00		
1156′ to 1265′	5.50		
1266′ to 1375′	6.00		
1376′ to 1485′	6.50		
1486′ to 1595′	7.00		
1596′ to 1705′	7.50		
1706′ to 1815′	8.00		
1816′ to 1925′	8.50		
1926′ to 2035′	9.00		
2036′ to 2145′	9.50		
2146′ to 2255′	10.00		
2256′ to 2365′	10.50		
2366′ to 2475′	11.00		
2476′ to 2585′	11.50		
2586′ to 2695′	12.00		

* Contribution at the rate of $25.00 for each 100′ above 2000′ is required in addition to the minimum monthly charge of $4.50.

731 customers, and made service available to 205 additional farms and residences which did not take service at the time the lines were built.

This construction left 1386 possible miles of construction on January 1, 1936. During 1936, 596 miles of lines were built for 2313 customers and made service available to 631 non-customers. This left a remainder of 790 possible miles of construction, of which 400 miles is planned for construction in 1937 and the balance for succeeding years. Some idea of the size of the construction job accomplished from the beginning of the new extension program on October 1, 1935, to December 31, 1936, can be had when it is considered that 668 miles of lines were built in the fifteen month period as against 484 miles in the previous four years and nine months from January 1, 1931, to September 30, 1935. Or, stating the case in a different way, the average construction under the new plan has been 44.5 miles per month, against 8.5 miles per month for the previous period.

Cooperation with Other Agencies

(Brief abstract—In the full exhibit of the Company a more extended discussion of this section is given.)

State and County Committees

The New York State Farm Light and Power Committee was formed in 1935, composed of representatives of principal farm organizations. It set up County Farm Light and Power Committees of Similar Membership.

Company Cooperation with County Committees

The company provided representatives to address meetings called by County Committees, and schooled its Rural Service Representatives in laying out farm wiring installations which the Committees asked the company to furnish. County committeemen have assisted company in right-of-way difficulties.

Cooperation with State Colleges of Agriculture and Home Economics

The company provided representatives to attend Extension Meetings on uses for electricity on the farm, to answer questions regarding the line extension plan.

The Farm Electrification Council

The company is represented on the Farm Electrification Council, a committee of The Empire State Gas & Electric Ass'n. The Council has been in existence for ten years and has been responsible for the development of many important uses for electric service on the farm.

Research Fund

The company contributes to a Research Fund set up by The Empire State Gas & Electric Ass'n. This fund is used by the college to conduct studies on uses for electricity on the farm.

Wiring Sub-Committee

The Farm Electrification Council formed a Wiring Sub-Committee, of which an employee of Niagara, Lockport & Ontario Power Company was chairman, to draw up specification forms for use in making farm wiring plans. This sub-committee, on request of the college, assisted in revising Cornell Bulletin No. 204, "Electric Wiring for the Farm."

Other Special Committees

The company's Rural Service Engineer was a member of three other committees requested by the college to assist in revision and preparation of bulletins.

Cooperation with Cornell Dept. of Agricultural Economics

The company has furnished data on new rural lines to the Department of Agricultural Economics, to keep the department's maps up to date.

Farm and Home Week

The company has furnished a speaker in the person of its Rural Service Engineer on the Farm and Home Week Program at the N. Y. State Colleges of Agriculture and Home Economics, and expects to do the same in 1937. It plans to lend the services of Home Lighting Advisors and to supply lighting and wiring display material to the Home Economics College for an exhibit during the next Farm and Home Week.

Development of Rural Load

In discussing the subject of load building we shall start with the application for service and follow through the several steps to the point where appliances are installed on the customer's premises.

New Line Extensions

Applications may be received by mail, by telephone, or by personal call at the company office. In any event, after an application is received, a Rural Extension Representative goes over the proposed extension to determine its approximate length and number of possible customers in order to fix tentatively the minimum monthly charge (M.M.C.). He and the interested prospects endeavor to get as many signatures as possible on a "Form B" Application and each applicant is given a copy of the leaflet "More Power To You," Farm Wiring Recommendations, back numbers of *Electricity on the Farm,* "Life in the Country" and, depending upon the type of farm, a copy of "Electricity on the Dairy Farm" or "Electricity on the Poultry Farm." The prospective customers are cautioned in writing not to start wiring their premises until they are notified by the company in writing, that all rights of way have been obtained.

As soon as all signatures are complete on the Form B Application, it is turned over to the Accounting Department for credit investigation. Meanwhile, the Rural Extension Representative prepares a preliminary sketch of the proposed extension, one copy of which is given to the District Engineering Department. This department makes a sketch showing desired pole locations which is then turned over to the Rural Extension Representative or a Right-of-way man to obtain the necessary rights of way from the property owners. At the same time, Service Applications (Form A Contracts) are obtained from each customer.

When all rights-of-way have been obtained the line is released to the Construction Department to be staked and built. Customers are then notified in writing that they may proceed with their wiring, on completion of which the line will be built.

Farm Wiring Plans

As soon as negotiations as outlined above have progressed to the point where the Form B application is complete and it is reasonably certain that the line can be built, the Rural Service Representative calls on the applicants to discuss adequate wiring and to offer to make wiring plans and specifications for all good farms along the line. By discussing with each farmer the possible uses for electric service on his farm, a wiring plan can be made up to suit his present and future needs and which permits of expansion at a minimum of expense. At the same time the Rural Service man accumulates a good prospect list. He also suggests that the Home Lighting Advisor come to discuss home lighting fixtures, portable lamps, etc. The Home Lighting Advisor uses the leaflet "A Guide to Good Lighting" as a recommendation for lighting fixtures.

At this time the names of the prospective customers are given to the County Agricultural Agent. He then sends each customer a copy of Cornell Bulletin No. 204.

It has been our experience that 75% of these wiring layouts are installed as specified, and that in the case of the remainder the wiring as installed is more adequate than it would have been had no specifications been provided. Electrical contractors who opposed this wiring specification service when it was first instituted are now frank to admit that it has raised materially the standard of wiring being installed in this territory.

Niagara, Lockport and Ontario Power Company was a leader in the introduction of non-metallic sheathed cable for interior farm wiring, and of service entrance cable. These materials have made it possible for the farmers to get more complete and more durable wiring in their barns and other outbuildings for less expense than was possible when conduit and other metal-clad wiring systems were required. It is safe to say that in the past year, ninety per cent of the farm wiring in the company's territory was installed in non-metallic cables.

Where the new customer installs a range, the company will install its standard 3-wire, 60 ampere service entrance and range wiring free of charge. Where a 100-ampere service or a pole-meter service is required, the cost of the 60-ampere service is contributed by the company toward the required facilities.

Polemetering is specified in those cases where load in each of two or more buildings is apt to be large, or other considerations point to this as the most economical service installation.

Appliance Sales

In most of the company's territory, domestic load building is promoted by District Representatives. Each of these men reads about 800 meters per month in village territory or 600 per month in distinctly rural territory, makes service cut-ins and cut-outs, and looks after collections and other matters as well. Where the District Representative Plan is not in effect, Domestic Salesmen are employed.

The Company sells electric ranges, water heaters, and better-sight lamps. It sells no other domestic appliances as it has been able to develop a satisfactory volume of sales through other dealer outlets such as electrical appliance, hardware, and department stores.

The sale of farm appliances is promoted by Rural Service Representatives. These men are individuals who have some knowledge of both farming and electrical matters and who have had experience in selling to farmers over a considerable period of time.

The Company sells electric brooders; poultry water warmers; dairy utensil scalders, sterilizers and water heaters; soil heating equipment; dairy barn ventilating fans; and miscellaneous heating devices in those districts in which public acceptance has not been well established. The Company does not merchandise water systems, milk coolers, milkers, separators, motors, or other motor-driven appliances, but actively promotes the sale of these appliances through established dealers.

Monthly reports of Farm Equipment Sales are sent in to Buffalo by each district. These are combined into a composite report for the entire territory.

The results of the activities of these Rural Service men is indicated in Table II which shows the appliances known to have been sold in 1936 as a result of the efforts of the Rural Service men. Had it been possible to make a complete survey of all customers, it is very likely that many other new appliances would be found, this having been our experience in the past.

As sales of domestic appliances are not segregated between farm, other rural, and urban customers, it is not possible to give any data on the appliances covered by this classification.

A continuous effort is made to secure as customers the unwired premises along existing lines. The results of this activity are shown in Table III.

TABLE II—SALES OF FARM APPLIANCES, 1936

Appliance	No. Sold	Est. Kw	Est. Annual Kwhr	Est. Annual Revenue
Water Pumps	869	267	173,705	$7,080.72
Milk Coolers	102	71	126,566	3,358.92
Milkers	79	59	42,650	1,733.25
Motors	221	267	125,044	3,633.86
Misc. Motor Driven	24	9	3,020	135.00
Brooders	142	71	54,668	2,149.00
Battery Brooders	14	11	6,650	295.69
Poultry Water Warmers	360	50	45,160	1,449.13
Dairy Water Heaters and Scalders	16	32	35,900	841.50
Soil Heating	6	5	2,700	77.50
Incubators	21	16	9,403	336.19
Misc. Heating	8	2	806	30.00
Total	1,862	860	626,272	$21,120.76

TABLE III—OLD BUILDINGS WIRED AND CONNECTED TO EXISTING RURAL LINES

District	Unwired Bldgs. Jan. 1, 1936	Bldgs. Wired 1936	Unwired Buildings on New Rural Lines Built in 1936	Unwired Buildings Dec. 31, 1936
Angola	229	134	0	95
Avon	361	160	60	261
Batavia	660	134	152	678
Cattaraugus	526	106	78	498
Chautauqua	512	173	155	494
Ontario	1,273	239	275	1,309
Total	3,561	946	720	3,335

Advertising

The magazine *Electricity on the Farm* is sent monthly to all good farm customers, approximately 10,000 copies per month being distributed at present. We have used this magazine since it was first published, increasing our subscription as new customers are added to the lines.

In addition to our advertisement each month on the back cover of *Electricity on the Farm,* the same advertisement runs in each County Farm Bureau News in the counties where the company serves. Samples of these ads are illustrated.

Other mailing pieces have been developed from time to time.

Demonstration Electrified Farm

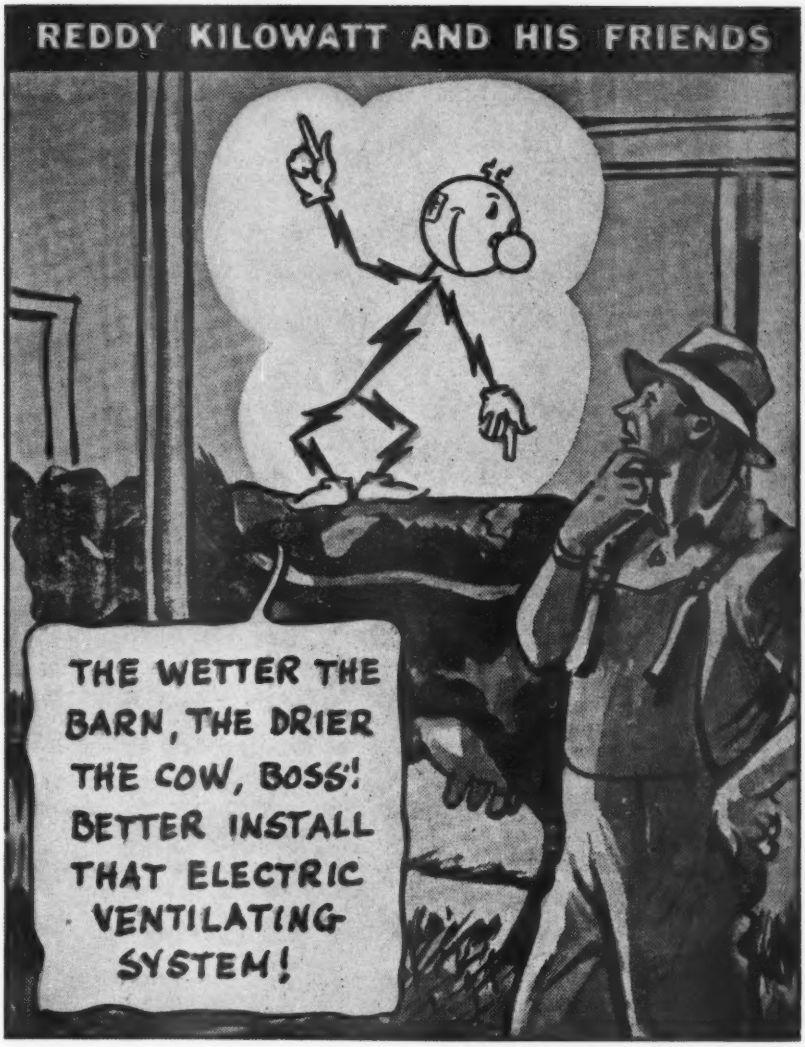
When the company began planning for its program of increased activity in rural extensions and farm equipment sales, it was considered advisable to establish a Demonstration Electrified Farm to augment the data on cost of operating electrical farm and farm home appliances already available from other areas and sources. After considerable investigation the farm owned and operated by Mr. Ralph W. Brundage of Oakfield, N. Y., was selected. This farm comprises 185 acres of land devoted to cabbage, potatoes, hay and corn, a poultry plant of 1200 hens and a 25-cow dairy, and is operated by its owner as his sole source of income. It is in no sense a "model" farm. It is extraordinary in the diversification of activities and the use of electric service.

Mr. Brundage received electric service in 1931. His minimum charge, since reduced, was $24.00 per month. He installed an excellent wiring system, motorized his milker and pump and installed a range and poultry-house lighting.

From then until the summer of 1934 he installed practically every common domestic appliance except an ironer, water heater and sewing machine, and purchased a 5 hp. portable motor and a feed grinder as well.

In August, 1934, the Company entered into an agreement with Mr. Brundage to use his farm as a Demonstration Farm for a period of five years, at the end of which either party may terminate the agreement.

To complete the electrification of the farm the Company loaned the following appliances: Ironer, Water Heater, Sewing Machine, Better Sight Table Lamp, Better Sight Floor Lamp, three 350 Chick Brooders, a 2400 egg Incubator, six Poultry Water Warmers, Dairy Utensil Scalder, 8-can Milk Cooler, Dairy Barn Ventilating Fans, Hay Hoist, and Ensilage Cutter. Any necessary wiring was installed by the Company. Mr. Brundage has since purchased another incubator, a duplicate of the one furnished by the Company. All major appliances are individually metered.


REDDY KILOWATT AND HIS FRIENDS
THE WETTER THE BARN, THE DRIER THE COW, BOSS! BETTER INSTALL THAT ELECTRIC VENTILATING SYSTEM!

Types of advertisements used by the company

In return for the use of this equipment, Mr. Brundage reads all meters at the end of each month and permits the farm to be inspected by visitors at all reasonable hours. The residence can be inspected by appointment. He pays for all electric energy used on the farm at regular filed rates. At the end of the demonstration period, he has the option to purchase any or all of the loaned appliances at their original cost less reasonable depreciation.

Mr. Brundage sends the meter readings and a record of work done by the major appliances to the Rural Service Department at the Buffalo office. Here they are compiled into a monthly report which is sent to the Company's District Managers, Rural Service men, Sales Supervisors and other interested employees, all County Agricultural Agents, Rural Service Departments of neighboring utilities, and to some of the staff at the New York State College of Agriculture. An annual report summarizing these monthly reports, is prepared each year in November as the year's records close October 31.

Farm Electrification Manual

Besides keeping the Rural Service men, New Business Department supervisors, and others in the district offices supplied with up to date information

TABLE IV—FARM SERVICE STATISTICS 1930-1936

Year	Number of Consumers Dec. 31	Average Number of Consumers	Total Kwhr Sold	Average Kwhr per Consumer	Average Revenue c. per Kwhr
1930	8,119	7,887	5,436,666	689	6.24
1931	9,126	8,586	6,772,481	789	5.73
1932	9,861	9,622	7,728,133	803	5.68
1933	9,944	9,923	7,760,773	782	5.64
1934	10,188	10,038	8,178,310	815	5.26
1935	10,673	10,422	9,012,440	865	4.92
1936	13,126	11,993	11,043,759	921	4.43

and prices of farm appliances, the Rural Service Department has prepared and furnished to these same individuals a Farm Electrification Manual. This consists of an 8½ x 11 loose-leaf binder in which technical data and literature is filed. This is kept up to date and additional information supplied from time to time.

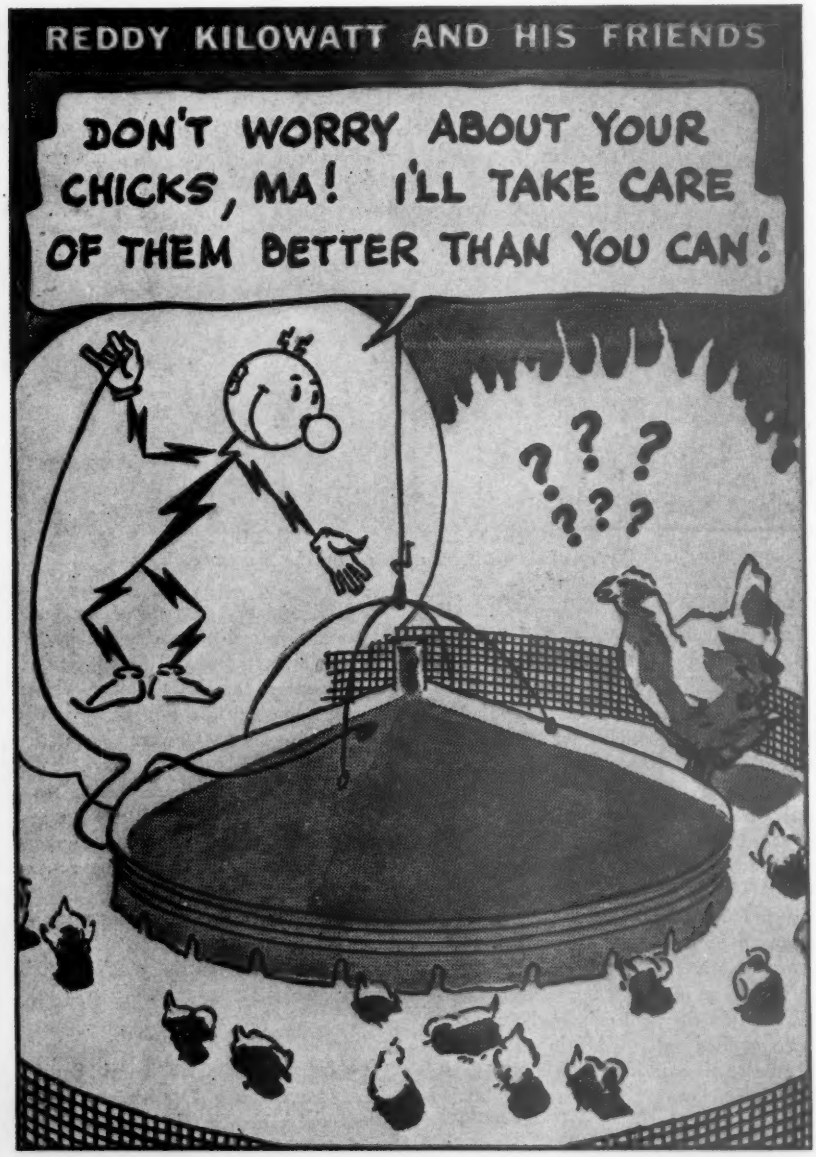
Radio Broadcasts

The Erie County Farm Bureau conducts a 15-minute Radio Program over Station WBEN, Buffalo, every Saturday noon. On request of the County Agricultural Agent, the Company's Rural Service Engineer has given four talks during 1936 on seasonal subjects: Farm Wiring, Poultry House Lighting and Poultry Water Warming, Electric Brooding, and Soil Heating.

Conclusion

We believe that the methods of rural business promotion and the cooperation with other agencies have been sound policies. They have resulted in a general feeling of good will between all agencies concerned with rural electrification.

A steady and very encouraging increase in use of electric service by farm customers has been apparent, see Table IV, ever since the organization of the Rural Service Department. A slight drop in the consumption per customer occurred in 1933. This was only a temporary condition, however. Improved economic conditions, the general publicity given to Rural Electrification from all sources, and the efforts of the company have brought up the energy consumption per farm customer 13% in the last two years, while the average price per kilowatthour has declined 15.8% in the same period.



Electrical Housewares Program Introduces Booklet On Buffet Entertaining

ELECTRICAL Buffet Entertaining Month, to be observed by the industry during October, will mark the occasion of the wide distribution of a smart new booklet on electrical table cookery and buffet menus.

Fae Huttenlocher, well known editor associated with *Better Homes and Gardens* Magazine and a national authority on the use of electrical table cookery appliances, wrote the text. The material in "Electrical Buffet Entertaining" is excellently presented to emphasize the convenience, attractiveness, efficiency, and economy of entertaining electrically.

Department stores, utility companies, distributors and manufacturers of electrical tableware and their dealers will employ quantities of this publication to stimulate consumer interest in electrical merchandise during the season when national attention is focused on this subject.

Prices of the booklet may be obtained from the Edison Electric Institute, or the Electrical Housewares Program, 420 Lexington Avenue, New York.

McGraw Prize Paper

Practical Aspects of Cavitation and Pitting

By J. M. Mousson

ALTHOUGH pitting has been the subject of considerable discussion in the past, yet when faced with a particular problem in course of design, manufacture, or maintenance of structures and machinery subject to attack by cavitation, it is still exceedingly difficult in many instances to arrive at a proper solution. The reason is obvious. Rather than provide a broad and rational basis useful in coping with any type of problem, the concerted efforts made by many engineers in pooling prototype experience served undoubtedly to enhance the complex nature of the attack and the damage.[1, 2]* Aside from physical characteristics typical perhaps only to one or the other installation the difficulties in coordinating prototype experience was generally recognized to lie in the absence of an accurate standard of comparison. To overcome these obstacles various attempts were made by different investigators, but the data made available were either too specific, that is, dealing with one particular application, or too general in character leaving many questions subject to speculation.

Recognizing the need for further progress regarding the concepts involving chiefly the practical aspects of cavitation and pitting, the Safe Harbor Water Power Corporation decided in 1934 to sponsor a research program of its own in the hope that the results obtained would be generally useful for the operation and maintenance of present equipment as well as for the design and manufacture of future installations.

Outline of Research

1. As a first step an apparatus should be made available for producing cavitation artificially but in such a way as to leave no doubt regarding the similarity of the phenomenon under experimental conditions to that occurring in prototype installations. At the same time pitting should take place at a very accelerated rate to permit the testing of a large variety of materials within a reasonable time interval.

2. The specimens to be tested should consist of cast, forged, rolled, welded, sprayed and surface treated materials; in short, every kind of alloy condition which may be given consideration in manufacturing or maintaining hydraulic equipment.

3. The materials should represent a good cross-section of alloys used so far in actual practice. In addition, however, if metallurgical aspects or purely scientific reasons should make the inclusion of other materials desirable, they should also be tested even though there may be no immediate or future practical application for them.

4. A study should be made to explain the nature of the failure of materials due to cavitation. Particular attention should be paid to the metallurgical aspects in order to find as many factors as possible, controllable or uncontrollable, influencing the resistance of materials with respect to the punishment under consideration.

5. An attempt should be made to correlate pitting due to cavitation and erosion due to water jet to see whether or not the results obtained could be used as a basis in connection with both types of stress applications.

6. Last but not least, any phenomenon discovered in the course of testing affecting directly or indirectly cavitation itself, should be carefully followed up to see whether it had any bearing on design, operation and maintenance of hydraulic machinery.

MR. MOUSSON

Mr. Mousson is the winner of the First McGraw Prize for 1937.

A native of Switzerland, Mr. Mousson was educated at Zurich, and studied civil engineering at the Swiss Federal Institute of Technology, graduating in 1926. He came to the United States in 1928 on an extensive study tour of hydroelectric developments and was so impressed by the opportunities in this country he decided to remain.

He was Designing Engineer with the Pennsylvania Water & Power Company from June, 1928, to March, 1929. He was then employed by the Electric Bond and Share Company until November, 1929, when he returned to the Pennsylvania Water & Power Company. Since that time he has served on the engineering staff of the Pennsylvania Water & Power Company and the Safe Harbor Water Power Corporation as Designing, Sponsor, and Hydraulic Engineer.

Cavitation Testing Apparatus

a. Design of Test Stand

It is obvious that for the design of the test stand, past experience by other investigators should be given careful consideration. Previously two fundamentally different principles had found application. The first one, and the more widely used, produced a zone of cavitation by directional flow of water and stationary boundaries designed so as to cause a discontinuity in the boundary layer, while the second one accomplished the same thing without a directional motion of the liquid but by moving part of the boundary to and fro at moderate or high frequency.

In connection with the first group of testing apparatus both recirculating and open systems have been used. Since dissolved air and perhaps other gases are liberated from the fluid in the low pressure region without complete reabsorption taking place after the collapse of the cavities there could be some doubt regarding the consistency of the attack in case a recirculating system was adopted. Hence a continuous fresh

* Reference numbers apply to Bibliography.

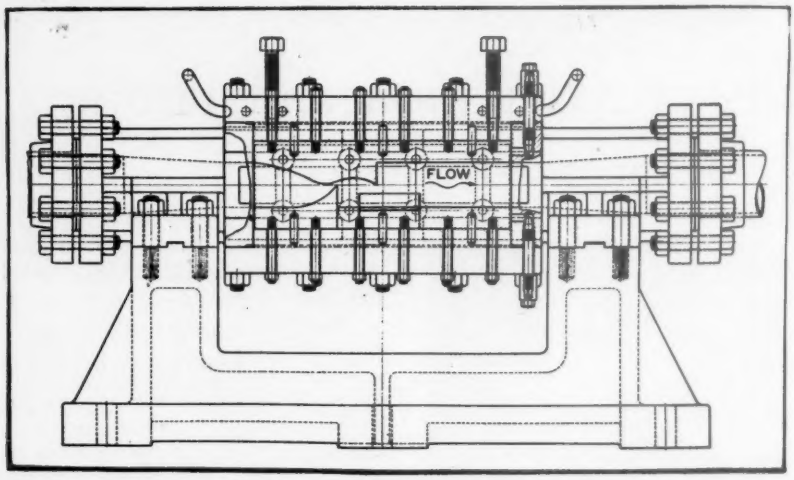


Fig. 1—Holtwood Cavitation Test Stand. Scale: 1 inch = 10 inches.

water supply was more desirable. This undoubtedly could have been arranged very easily with a vibratory apparatus,[3] but here the main difficulty is in the correct interpretation of the punishment, because impact stresses produced by the collision of fluid and boundary are superimposed on the stress application caused by cavitation. In view of the above a test stand was decided upon having stationary, especially designed boundaries together with a non-recirculating system whereby fresh raw water was continuously supplied and wasted after having passed through the test stand. Provisions, however, were made for recirculation in case this would be required for special tests later on.

The specimens had necessarily to be as small as possible for accurate loss determination. Hence pitting had to be concentrated on a small area. Some thought was being given to obstructions protruding into the water passage, such as were used by De Haller[6] and Voith,[7] or a Venturi profile as used by Schröter,[8, 9] when data regarding a new nozzle developed by Walchner[10] were made available, which likely could satisfy all requirements. This type of apparatus consists essentially of two weirs as shown in Fig. 1. In addition to some minor changes in the weir shapes and orifice dimensions one major modification was made in the location of the specimen. In the original scheme of Walchner a single specimen was placed opposite the guiding weir whereas the final design adopted provided for two dovetailed specimens inserted into the parallel side walls opposite each other. This modification was made because preliminary tests showed pitting on the sides to be decidedly more severe than opposite the guiding weir. At the same time the insertion of specimens in the side plates had the advantage of testing duplicate samples simultaneously giving a higher degree of test accuracy without increasing the number of runs. The dimensions of the samples were 4 x 1¼ x ¼ inch. (See Fig. 2.)

Since earlier cavitation investigations have indicated growing intensity of blows with increasing fluid velocity[6] and frequency of collapse to be proportional to throat velocity,[15] it was desirable to have as high a head on the nozzle as could be conveniently made available in order to accelerate pitting as much as possible. For this reason the test stand was installed in the Holtwood steam station of the Pennsylvania Water & Power Company located on the Susquehanna River at Holtwood, Pa. Using a raw water pump and a boiler feed pump in series, a maximum head could be provided of 1250 ft and a water quantity of 400 gallons per minute.

b. Calibration of Test Stand and Loss Determination

To arrive at the most suitable test conditions a series of runs was carried out keeping either the back pressure constant and varying the head pressure or vice versa. The pressure upstream of the nozzle could be regulated by the speed of the boiler feed pump, whereas the pressure downstream of the nozzle could be controlled by a valve. Based on the results as shown in Fig. 3 standard testing procedures were adopted using a head pressure of 480 lb per sq in and a back pressure of 25 lb per sq in. Under these conditions the throat velocity was about 265 ft per second. The duration of each run was 16 hours. The amount of pitting was determined by weighing the specimens before and after a test. For comparative purposes, however, the loss in volume was used, compensating for the difference in specific gravity of the various materials.

It was thought essential to check the test conditions at periodic intervals, using a standard specimen consisting of rolled stainless 18-8 chrome nickel steel. This material was chosen due to its close manufacturing tolerances and freedom from impurities. It may be seen from Fig. 4 that the losses obtained were not constant but vary with the water temperature and were found to be proportional to vapor pressure within the range of experiments. By means of a recirculating system the influence of seasonal water temperature variation was checked with artificially controlled temperatures. These tests were repeated with boiler plate steel, sheet brass and rolled copper bus bar and three different types of welding deposits and the same characteristic was indicated. In view of the temperature effect all results obtained with the test stand had to be corrected based on the ratio of vapor pressures to a common temperature arbitrarily assumed to be 20° C.

Although the temperature correction was based exclusively on the ratio of vapor pressures which for all practical purposes appears to be of sufficient accuracy, it is recognized that theoretically surface tension may also contribute in

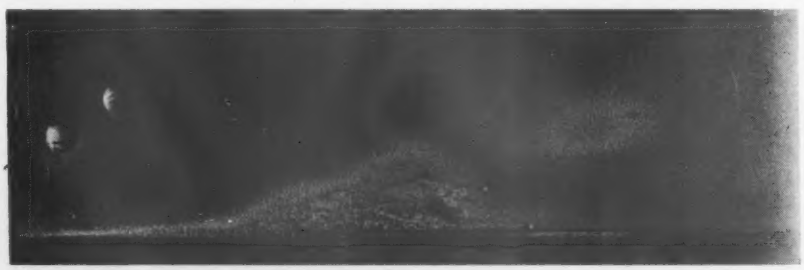


Fig. 2—Cavitation Specimen after 16 Hours' Exposure. (Spec. No. 97, Table VI). Mag. 1¼ Diam.

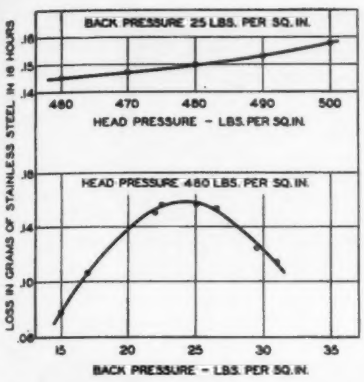

BACK PRESSURE 25 LBS. PER SQ. IN.
HEAD PRESSURE - LBS. PER SQ. IN.
HEAD PRESSURE 480 LBS. PER SQ. IN.
LOSS IN GRAMS OF STAINLESS STEEL IN 16 HOURS
BACK PRESSURE - LBS. PER SQ. IN.

Fig. 3—Calibration of Test Stand.

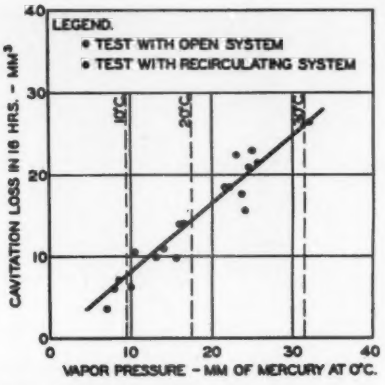


Fig. 4—Effect of Temperature on Pitting.

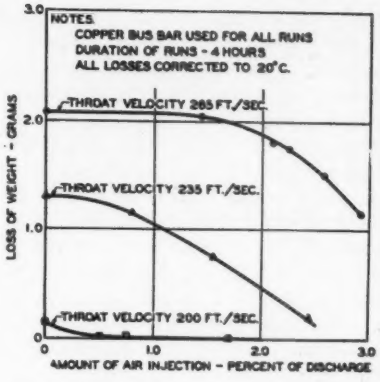

NOTES.
COPPER BUS BAR USED FOR ALL RUNS
DURATION OF RUNS - 4 HOURS
ALL LOSSES CORRECTED TO 20°C.
THROAT VELOCITY 265 FT./SEC.
THROAT VELOCITY 235 FT./SEC.
THROAT VELOCITY 200 FT./SEC.
LOSS OF WEIGHT - GRAMS
AMOUNT OF AIR INJECTION - PERCENT OF DISCHARGE

Fig. 5—Effect of Air Content on Pitting.

some measure to the intensity of cavitation.[16] Surface tension decreases with increasing temperature and it may be that cavities collapse more readily in warm rather than cold water.[17]

Some consideration had to be given to the possible influence of the air content which is also subject to seasonal variation. The Smithsonian tables on Physics give some information on the natural air content in water at various temperatures:

Temperature Centigrade	*Absorption of Air in Per cent of Volume*
0	2.47
5	2.18
10	1.95
15	1.80
20	1.70

Tests were carried out with artificial air injection with the air introduced on the suction side of the boiler feed pump. The results obtained are shown in Fig. 5. Since with a throat velocity of 265 ft per sec about 1% of air is required on and above the natural air content to show any effect on pitting and in view of the fact that the natural air content variations could be expected to be not more than 1% for the temperature range in river water available, no correction needed to be applied to the results to compensate for the seasonal variation of air absorption. From the curves on Fig. 5 it is, however, of interest to note that for lower throat velocities, that is, less severity of punishment, some influence of the seasonal air content variation may be expected.

Practical Aspects of Cavitation Characteristics

a. Air Injection

The results as found with air injection were important from a practical point of view because under the velocity conditions present in many hydraulic installations air could perhaps be used

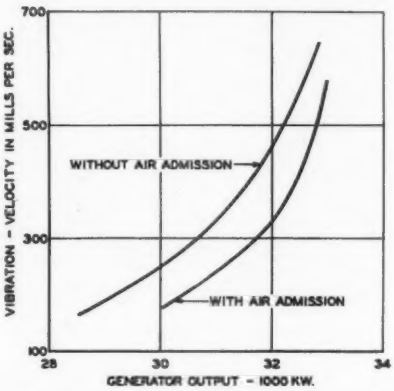


Fig. 6—Effect of Air Injection on Vibration of Unit at Safe Harbor.

to good advantage as a cushioning medium to reduce effects from cavitation. It must be recognized, however, that the volume of air required to render the punishment due to cavitation ineffective deems it essential to carry out the injection in such a way that the major portion of the air will find its way to the particular location desired. From an economic point of view it would be prohibitive in most cases to provide the necessary percentages of air all over the water passage. To judge better the practical value of air injection one specific installation may be discussed in detail.

On some propeller type units both of the fixed blade and the Kaplan type, serious vibrations have been found at high gate openings. At Safe Harbor, for instance, vibration alone was the determining factor for the gate limit under normal operating conditions. Due to the hazard involved short periods of full load or overload had to be avoided as much as possible.

In the past, two different theories have been developed to explain the origin of the vibrations. One attributes vibrations to the speed of rotation of the central rotating body of water in the draft tube below the runner,[18, 19] while the other suggests the instability of a void below the runner deflector as the origin of vibration.[20] It is thought that this void or cavity forms because of the water being unable to follow the contours of the deflector and due to the central vacuum developed by the centrifugal force of the rotating body of water in the draft tube. As a remedy, injection of air through the head cover was proposed. Provided the second theory referred to above was correct this procedure could be successful as air would cushion blows originating from the collapse of the cavities below the deflector. Since the relative velocity between air and water would be negligible in comparison to the velocity of the water there could be little doubt that air introduced through the head cover would actually find its way to the desired location. As may be seen from Fig. 6 vibrations were materially reduced permitting an actual gain of more than 1000 kw per unit or 6000 kw for the present installed capacity. The quantities of air required are 125 cfm per unit and injection is now a standard operating procedure.

Up to the present time the application of air to prevent pitting has not been given serious consideration. As it is more difficult to provide the desired quantities over the widely distributed areas of considerable magnitude, model tests may likely be used to good advantage to provide proper guidance of the air. Throat rings, draft tubes or pump outlets could perhaps be efficiently protected by an air curtain formed by air escaping from a perforated pipe ring inserted flush with the circular wall section of throat ring and draft tube above or below the runner respectively. With

introduction of air upstream of the runner there is the possibility of reducing effects of gap cavitation. Where pitting is caused in the wake of the stationary vanes of speed rings, air could be admitted through these vanes to enter the water passage on the downstream side close to the root. This scheme may have some possibility for present installations as in some cases the stay vanes are hollow for steam admission to prevent clogging up of the pit due to frazil ice. Needless to say there are many possibilities of air injection in connection with gates, butterfly valves, needle valves, separators, etc. It may even be thought of in the future to use air for prevention of pitting on propellers by letting air escape from the suction side of the blades, the air being fed to the blades through the hollow propeller shaft.

b. Effects of Temperature

Recognizing that the severity of the punishment varies with the temperature, some practical conclusions may be arrived at. In view of the results given in Fig. 4, it is evident that for hydraulic equipment subject to cavitation and operating part or the entire year in warm water, more serious thought should be given to protection than for those installations operating in cold water at all times.

Since cavitation also grows more destructive with increasing velocity (see Fig. 5) it may be advantageous to distribute the loads on various units whenever possible, particularly during the warm weather period, rather than to operate a minimum number of units at high gate opening. It is realized that this may be only justified when efficiency characteristics of the equipment permit such operation from an economic point of view or where the saving in equipment from the attack may overbalance a sacrifice in efficiency. Here again comes to light another advantage of the adjustable blade propellers which have a high part load efficiency making such operation desirable both from a pitting as well as from an efficiency point of view.

Possible effects of temperature cannot be overlooked when comparing pitting of materials used on various installations. Based on the results obtained and presented in Fig. 4 excellent performance records may be expected in cold or moderately tempered geographical regions, whereas in tempered or tropical climates moderate or severe pitting can be found for identical materials in spite of similar physical dimensions and operating conditions of the equipment.

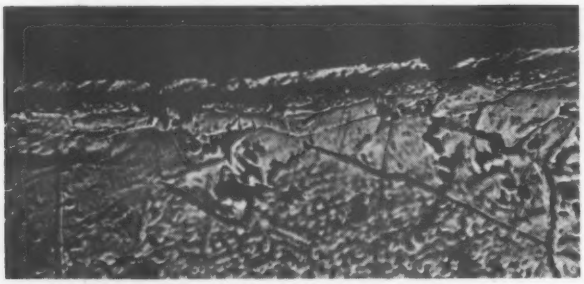


Fig. 7—Gold Plated Copper Bus Bar after Light Punishment. Mag. 500 Diam.

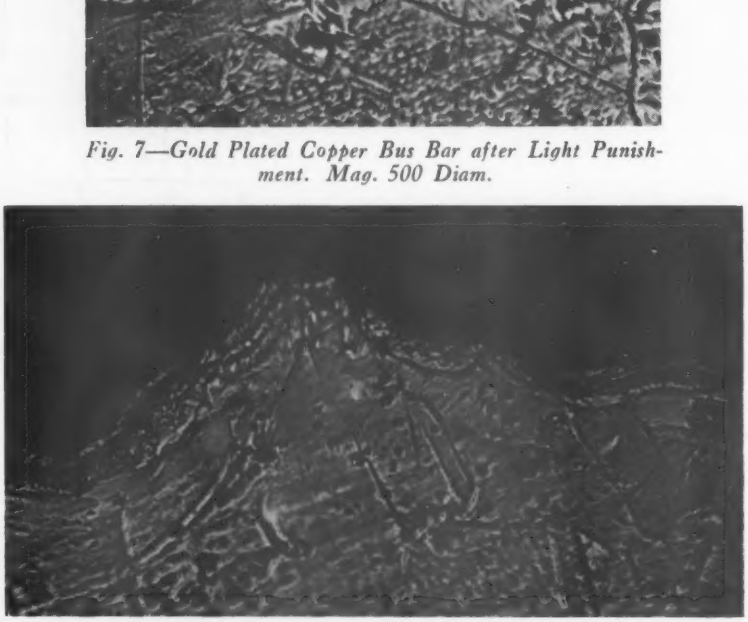


Fig. 8—Gold Plated Copper Bus Bar after Moderate Punishment. Note deformation of Copper and Distortion of Surface with much of the Plating Intact. Mag. 500 Diam.

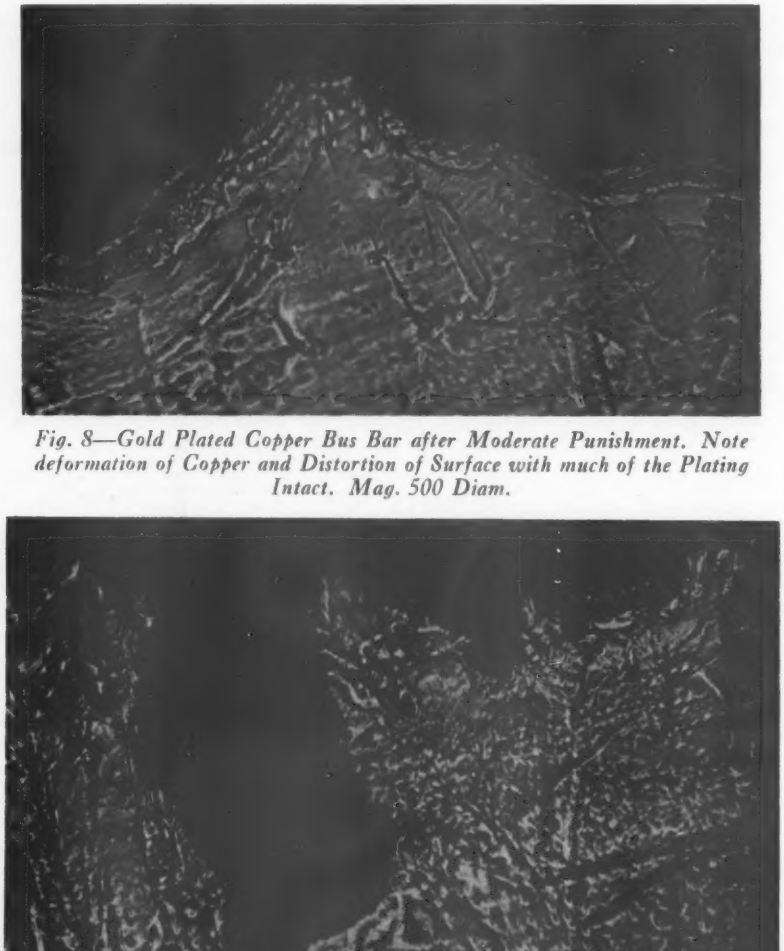


Fig. 9—Gold Plated Copper Bus Bar after Heavy Punishment. Note that capacity to Yield has been exhausted, and that some Copper has been lost. There is little left of the Gold Plating. Mag. 500 Diam.

Metallurgical Aspects of Pitting

a. Nature of Failure

Prior to this research it had already been recognized that the failure caused by cavitation was primarily mechanical. Corrosion, of course, should not be entirely disregarded as surfaces roughened by this chemical attack may pit more easily,[6] and because corroded surfaces are conducive to bring into existence small local zones of cavitation. The nature of the mechanical failure, however, has been the subject of consider-

able speculation. Up to the present time the only alloy characteristic definitely found to influence the resistance was hardness, as earlier tests indicated an increased resistance with growing Brinell hardness.[10] The above two factors undoubtedly have contributed in a large measure to the adoption of stainless steel for hydraulic turbine blading in Europe for various installations.

Based on the microphotographic analysis of many specimens in course of this research it may be concluded that with regard to the mechanical failure the following alloy characteristics are of influence: yield point, capacity of deformation, tensile strength, fatigue limit, hardness, induced hardness or cold working qualities, grain size, grain boundaries, grain shape, grain structure, distribution of alloy constituents, chemical composition, impurities and crystallographic properties. Although one or the other of the above characteristics may be of far reaching influence in one particular case nevertheless it should be borne in mind that all the other characteristics contribute their share in any case, and are of vital importance particularly when their individual influences are combined to a composite effect. At the same time it should not be overlooked that a change in some of the above characteristics necessitates invariably a change in some of the others making it difficult or even impossible to grade the various influences according to their importance.

The nature of the failure and the complexity of the influences contributing to resistance are, of course, related directly to the type of stress application exerted by cavitation. In the first place since we are dealing with the collapse of cavities, a phenomenon perhaps best definable as implosion in contrast to explosion, relatively high initial stresses may occur regardless of the amount of energy liberated, because the stress application is concentrated over an exceedingly small area. Secondly, the stresses may vary with each blow. The highest unit stresses are to be expected when the collapse is in direct contact with the boundary whereas a gradual reduction in unit stress occurs with growing distance between center of collapse and boundary. Thirdly, we have not one stress application but an exceedingly high number of applications in rapid succession. This latter phenomenon is perhaps best illustrated by the fact that De Haller[6] measured under velocity conditions comparable to those in the Holtwood test stand approximately

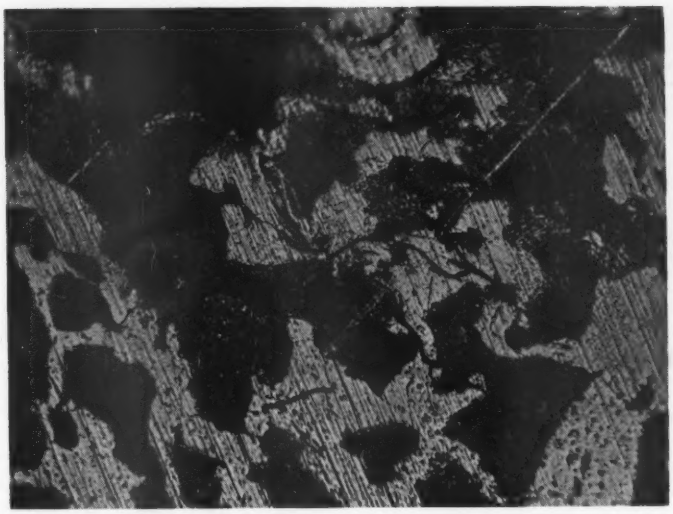


Fig. 10—Fatigue Cracks in Safe Harbor Turbine Steel. (Spec. No. 10, Table II). Mag. 500 Diam.

20,000 to 25,000 blows per second over an area of less than .003 square inches, which would mean more than one billion blows in course of 16 hours chosen as the test duration.

In view of the characteristics of the stress application the nature of the failure as indicated by the microscopic analysis is not surprising. In the surface grain layer or layers plastic deformation is observed. With higher yield points more resistance is offered by the material. It is important to bear in mind that the yield point and any other of the physicals referred to are determined with specimens of relatively large size and these physicals may only be indicative and not absolute values with respect to the resistance offered to the punishment by cavitation due to the inherent differences in the stress application. Under cavitation this area is of microscopic magnitude whereas in course of the determination of the standard physicals, stress is applied evenly over a large cross-section. Since it is possible that yield and fatigue limits for individual grains may be considerably lower than for large cross-sections consisting of many grain complexes, no definite conclusions may be drawn at the present time regarding the absolute magnitude of the actual unit stress exerted by cavitation. At the same time the fact should not be lost sight of that the maximum unit stress applied may be limited by the elasticity of the water.[5]

Deformation increases until the capacity to yield has been exhausted, at which time cracks may develop. Successive stages of destruction due to yield and plastic deformation can best be illustrated by a series of microphotographs. Figs. 7-9 incl. show a specimen consisting of gold plated copper bus bar. As may be observed from Fig. 8 no cracking in the copper is apparent after considerable deformation and even the gold plating shows little damage in this stage.

It may be surmised that each material has its own capacity of yield absorption and the number of successive deformations may vary considerably prior to cracking. In the grain layers immediately below those subjected to plastic deformation and where already some reduction in unit stress due to distribution has taken place, fatigue cracks have been observed. Their appearance is not surprising considering that fatigue failures under repeated stress application are usually found at considerably lower unit stress than those required for yield. (See Fig. 10.) These fatigue cracks may progress in any direction and should it be toward the surface part of the material may break away. The relationships of yield point capacity of deformation and fatigue limit differ in various materials and depending upon these certain types of failures may predominate. For instance, should the capacity to yield be exhausted prior to fatigue failure, loss in metal may occur exclusively due to the progress of the cracks in the zone of plastic deformation. On the other hand should the fatigue limit be relatively low in comparison to yield, material may be lost entirely due to fatigue cracks breaking through to the surface before appreciable or any deformation has taken place. In view of the above it may be concluded that a

Fig. 11—Plain Cast Iron. Note the Ferritic Structure with Flakes of Free Carbon. (Spec. No. 1, Table I). Mag. 500 Diam.

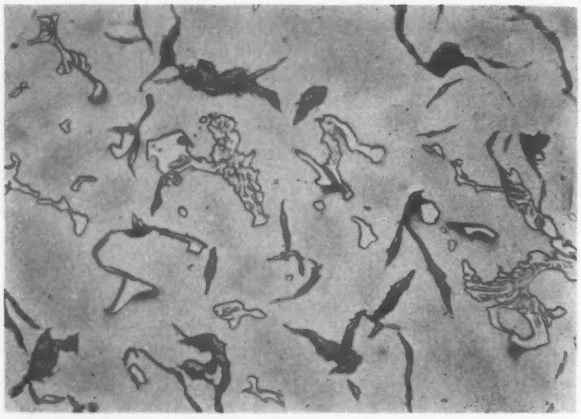


Fig. 12—Nickel Copper Cast Iron. Note Austentic Matrix and relatively fine Distribution of Free Carbon. (Spec. No. 7, Table I). Mag. 500 Diam.

large variety of failures may occur depending not only upon the physical characteristics of the materials but upon the location with respect to the zone of collapse and upon the type of cavitation itself, that is frequency and intensity of blows.

It should be pointed out that the tensile strength is also of importance as it is in some measure related to fatigue. The higher the tensile strength the higher is usually the fatigue limit and the tensile strength may serve as a basis of approximate fatigue limit determination. Yield point, capacity of deformation, tensile strength, and fatigue limit may be termed primary influences as these characteristics have direct bearing upon the nature of the failure. All other alloy characteristics referred to above relating to hardness and grain structure may be termed secondary, not with regard to their importance but because they do not change the nature of the failure, and rather govern either the magnitude of the yield point and capacity of the deformation or the location and the progress of the cracks in the zones of deformation or fatigue. The importance of these secondary influences may perhaps best be illustrated in course of discussing the results obtained with various materials.

b. Pitting Resistance of Materials

The results obtained with the test stand and the metallurgical data available for the materials investigated are compiled in a series of tables. The materials are grouped according to chemical composition and type of condition, that is, whether the material is cast, rolled, forged, surface treated, electric arc welded, acetylene welded or sprayed. It is, of course, impossible to discuss all the data in detail but an attempt is made to cover the essentials.

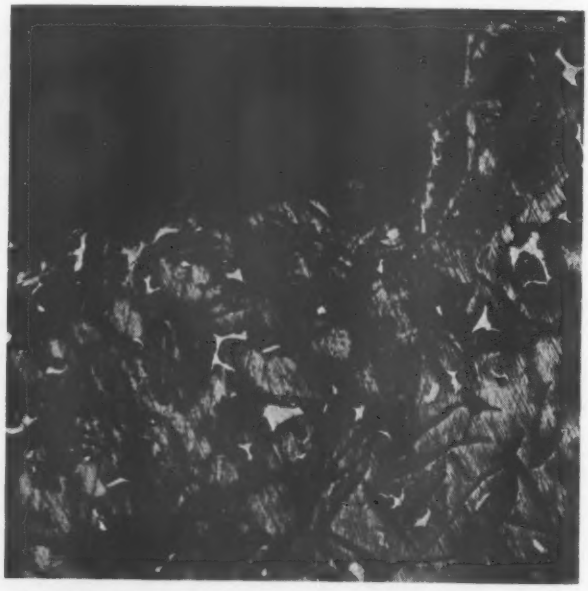


Fig. 13—Nickel Copper Cast Iron. Note large Flakes of Free Carbon. (Spec. No. 5, Table I). Mag. 100 Diam.

1. *Cast, Rolled and Forged Materials*

An interesting point to be noted from Table I is the initial protection afforded by the casting skin as evidenced by the difference in loss of specimens No. 1 and No. 2. Grinding of castings to smooth out unevenness in the surface exposed to cavitation should, therefore, be avoided as much as possible. This, of course, is not only true for irons but for steels and non-ferrous alloys as well.

Taken at a glance the plain and alloyed cast irons of Table I show rather large losses when compared with those of plain and low alloyed steels in Table II. The reason may be attributed to the free carbon content of the irons present in form of flakes. (See Figs. 11-13.) Keeping in mind the nature of the punishment high stress concentrations are likely to occur in the vicinity of the flake tips. Comparing for instance the loss of the nickel copper cast irons with specimen No. 84, Table V, consisting of an alloy similar in chemical composition except for the fact that no free carbon content is present in form of flakes, it becomes evident that stress concentrations should be avoided in case a high resistance is desired.

From Fig. 14 it is further apparent that there is a definite influence of Brinell hardness which may, however, be overshadowed by one originating

from the grain structure. An austenitic matrix in which various constituents form a solid solution (Fig. 12) appears to be far superior to one of the ferritic type consisting of separate complexes of elements or combination of elements (Fig. 11). The reason for this phenomenon lies in the strain hardening characteristics of the austenite. Since the punishment of cavitation can be regarded as a form of cold working, it is not surprising that decided increases in hardness have been found in the areas close to the attacked zone of those specimens consisting of materials showing good cold working characteristics. From this we may conclude that not only the original hardness is of importance but also the hardness which may be obtained in course of the punishment under cavitation.

From microphotographs of Figs. 11 to 13 and Fig. 14, another interesting conclusion can be drawn. In spite of the austenitic matrix of specimen 5 an unusually high loss was obtained. The reason for this peculiarity lies very likely in the distribution of the free carbon content. Whereas ordinarily a fine distribution may be observed, that is, small flakes but large in number (see Fig. 12)

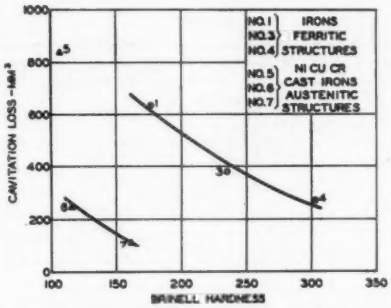


Fig. 14—Effect of Brinell Hardness upon Pitting of Plain and Alloyed Cast Irons.

specimen No. 5 showed very large but fewer flakes (see Fig. 13).

In view of the fact that the strain hardening effect in the iron group is superimposed by the influence of the carbon distribution, it may be well to check this phenomenon by data obtained with cast and rolled stainless steels. For instance in Table V, specimens Nos. 64 and 81, show a very large difference in pitting resistance. Both types of specimens originate from ingot croppings. In spite of the fact that the yield point and the original hardness of the austenitic 18-8 chromium nickel steel are lower than that of the stainless 17% chromium steel, the pitting resistance of the former alloy is far superior. All other austenitic stainless steels listed in Tables V and VI, whether they are of the 18-8, 24-12 or 26-13 chromium nickel variety, showed the same favorable characteristics. That strain hardening actually takes place on this variety of alloys is illustrated by Fig. 15.

Hardness tests carried out on various other alloy specimens showed the same tendency although their cold working characteristics are not as favorable as those of the austenitic stainless chromium nickel variety. Some results obtained on non-ferrous alloys listed on Table VIII are indicated below:

		Rockwell Hardness (B Scale) in Various Zones		
Number	*Alloy*	*Not Affected By Cavitation*	*Secondary Zone*	*Primary Zone*
132	Aluminum Bronze	67.0	80.2	83.9
133	Gun-Metal	29.2	49.1	57.0
134	P.M.G. Metal	65.3	74.7	73.5
136	Hy-ten-sl Bronze No. 3	89.2	97.1	96.8
139	Hy-ten-sl Bronze No. 2	86.1	93.5	95.0
140	Hy-ten-sl Bronze No. 1	98.3	103.0	103.5

Fig. 15—Strain Hardening of Rolled 18-8 Stainless Chromium Nickel Steel. Note well developed Slip Bands due to Cold Working; also Fatigue Cracks in Grain to the Left and Formation of Twin in Grain at Center. (Spec. No. 109, Table VI). Mag. 200 Diam.

TABLE I

TABLE I PLAIN AND ALLOYED CAST IRONS

No.	Alloy	Chemical Composition - Percentage of							Condition	Physical Properties		Cavitation Loss in 16 hrs. mm³ at 20°C.
		Total C	Mn	Si	Ni	Cr	Cu			Tensile Strength Lbs./Sq. In.	Brinell Hardness	
1	Cast Iron	3.18	.50	2.13				a	As Cast	25,000	171	636.0
2	Cast Iron with Casting Skin	3.20	.50	2.00				e	As Cast	25,000	200	396.0
3	Nickel-Tensyleron	2.54	.76	2.51	1.05			a	As Cast	56,000	235	376.0
4	5% Nickel Cast Iron	2.93	.50	1.36	4.81			a	As Cast	35,000	303	269.0
5	Ni Cu Cast Iron	3.10*	1.50*	2.00*	15.00*	1.00	7.00*	e	As Cast	18,000	107	837.0
6	Ni Cr Cu Cast Iron	2.77	1.00	1.86	1.48	1.88	6.00	a	As Cast	25,000	116	247.0
7	Ni Cr Cu Cast Iron	2.95	1.00	1.89	14.36	3.95	6.00	a	As Cast	35,000	161	109.0

a: Actual Analysis e: Estimated Analysis *Maximum

TABLE II

TABLE II CAST LOW ALLOYED STEELS

No.	Alloy	Chemical Composition - Percentage of										Condition	Heat Treatments					Typical Physical Properties					Cavitation Loss in 16 hrs. mm³ at 20°C.
		C	Mn	P	S	Si	Ni	Cr	Mo	V			Temp. Heated Deg. F.	Time Held Min.	Cooled In	Drawing Temp. Deg. F.	Time Held Min.	Cooled In	Tensile Strength Lbs./Sq. In.	Yield Point Lbs./Sq. In.	Elongation in 2 Inches %	Reduction of Area %	Brinell Hardness	
10	.33% Carbon Steel (1)	.33	.71	.032	.030						a	Annealed	1620	360	Furnace				70,250	38,900	35.0	47.2	159	62.4
11	Mn Steel	.45	1.51			.47					a	Quenched and Drawn	1725	90	Air	1225	240	Furnace	120,000	85,000	12.0	18.0	208	104.0
12	Mn Steel	.45	1.51			.47					a	Quenched and Drawn	1725	90	Air	1175	120	Air	140,000	100,000	18.0	30.0	285	79.6
13	.29% Carbon Steel (2)	.29	.80	.020	.020	.23	.28				a	Annealed and Drawn	1650		Furnace	800			71,500	48,000	32.0	49.8	133	57.8
14	Mn Ni Steel	.29	1.19	.032	.032	.36	1.55	.02			a	Quenched and Drawn	1600		Air	1250		Air	88,000	60,000	28.0	45.0	164	51.1
15	Ni Steel	.30	.70			.40	3.00				e	As Cast											194	42.1
16	Cr Steel	.20	.78			.48		1.68			a	Quenched and Drawn	1750	90	Oil	1175	120	Air	125,000	100,000	16.0	35.0	293	37.1
17	Mn Mo Steel	.29	1.28			.43			.13		a	Quenched and Drawn	1725	90	Air	1250	120	Air	85,000	55,000	22.0	40.0	162	152.0
18	Mo Steel	.27	.75						.52		e	Quenched and Drawn	1700		Air	1250		Air	85,000	55,000	20.0	30.0	192	73.6
19	Ni Cr Mo Steel	.28	.65				1.57	.60	.25		e	Quenched and Drawn	1700		Air	1250		Air	85,000	55,000	18.0	30.0	179	54.8
20	Ni Cr Mo Steel	.30	.65				2.00	.75	.25		e	Quenched and Drawn	1700		Air	1250		Furnace	100,000	65,000	18.0	30.0	188	41.7
21	Ni Cr Mo Steel	.31	.75			.45	2.15	.76	.15		a	Quenched and Drawn	1725	90	Air	1225	120	Air	105,000	70,000	20.0	32.0	201	30.7
22	Cr Mo Steel	.51	1.37			.48		1.11	.50		a	Quenched and Drawn	1725	90	Air	1200	120	Air	140,000	105,000			342	36.9
23	Cr Mo Steel	.51	1.37			.48		1.11	.50		a	Quenched and Drawn	1725	90	Air	1000	180	Air	200,000	170,000			528	11.5
24	Cr Mo Steel	.51	1.37			.48		1.11	.50		a	Quenched and Drawn	1725	90	Oil	400	120	Air	250,000	225,000			640	4.7
25	Cr Mo Steel	.22	.55					5.00	.50		e	Quenched and Drawn	1700		Air	1250		Furnace	110,000	75,000	16.0	30.0	158	30.2
26	Cr Mo Steel	.19	.76			.39		5.57	.47		a	Quenched and Drawn	1850	90	Air	1200	120	Air	110,000	75,000	16.0	30.0	215	14.9
27	Cr V Steel	.65	.65					1.00		.19	e	Quenched and Drawn	1600		Air	1200		Furnace					293	18.7

a: Actual Analysis e: Estimated Analysis (1) Safe Harbor Runner Steel (2) Electric Furnace Cast Steel

TABLE III

TABLE III ROLLED LOW ALLOYED STEELS

No.	Alloy	Chemical Composition - Percentage of											Condition	Heat Treatments			Typical Physical Properties					Cavitation Loss in 16 hrs. mm³ at 20°C.
		C	Mn	P	S	Si	Ni	Cr	Mo	V	W	Al		Temp. Heated Deg. F.	Cooled in	Drawing Temp. Deg. F.	Tensile Strength Lbs./Sq. In.	Yield Point Lbs./Sq. In.	Elongation in 2 Inches %	Reduction of Area %	Brinell Hardness	
30	.30% Carbon Steel	.30	.80	.040*	.040*								e	As Received			60,000				145	135.0
31	2% Nickel Steel	.19	.60	.018	.024		2.16						a	Hot Rolled			75,070	49,230	31.0	62.0	142	44.5
32	5% Nickel Steel	.12	.45	.25			5.00						a	Hot Rolled			104,000	79,000	29.0	70.0	191	25.0
33	Ni Cr Steel	.26	.24	.016	.028	.060	3.23	1.37					a	As Received			121,000	106,000	25.0	63.5	248	26.1
34	Ni Nitriding Steel	.18	.74	.014	.026	.14	3.57	1.38	.25			1.17	a	Quenched and Drawn	1650	Oil	1230	120,000	107,000	23.0	65.0	238	23.2
35	Ni Mn Steel	.70	9.92	.050	.010	1.56	3.23	.17					a	As Received				145,000	47,500	65.0	43.0	233	126.0
36	Cr V W Tool Steel	.45	.25			.30		1.40		.25	1.60		e	Annealed				99,000	78,000	20.2	47.8	175	57.3
37	Cr V W Tool Steel	.45	.25			.30		1.40		.25	1.60		e	Tempered			1600	145,000	130,000	17.0	30.8	298	43.4
38	Cr V W Tool Steel	.45	.25			.30		1.40		.25	1.60		a	Tempered			1100	221,000	190,000	14.0	41.0	415	30.5

a: Actual Analysis e: Estimated Analysis *Maximum

TABLE IV

TABLE IV. FORGED LOW ALLOYED STEELS

No.	Alloy	Chemical Composition - Percentage of										Condition	Heat Treatments		Typical Physical Properties					Cavitation Loss in 16 hrs. mm³ at 20°C.
		C	Mn	P	S	Si	Ni	Cr	Mo	V			Temp. Heated Deg. F.	Cooled in	Tensile Strength Lbs./Sq. In.	Yield Point Lbs./Sq. In.	Elongation in 2 Inches %	Reduction of Area %	Brinell Hardness	
40	Wrought Iron	.05	.007	.115	.080						a	As Forged			47,000	26,000	27.0	38.0	105	194.0
41	.22% Carbon Steel	.22	.52	.021	.026						a	Annealed	1500	Air	62,000	34,000	32.0	51.0	149	36.8
42	.49% Carbon Steel	.49	.66	.024	.021						a	Drawn	1100	Air	89,000	56,000	26.0	47.0	163	24.7
43	2.5% Nickel Steel	.25	.91	.018	.028		2.68				a	Drawn	1200	Air	88,000	61,000	29.0	60.0	173	34.0
44	3.5% Nickel Steel	.42	.66	.031	.028		3.34				a	Drawn	1200	Air	98,000	59,000	25.0	52.0	163	42.1
45	5% Chromium Steel	.15	.50*	.04*	.04*	.50*		5.00			e	Drawn	1200	Air	105,000	78,000	25.0	70.0	202	39.1
46	Vanadium Steel	.48	.78	.018	.019					.19	a	Drawn	1200	Air	96,000	59,000	24.0	47.0	208	15.1
47	Ni Cr Steel	.50	.60	.032	.027		1.25	.81			a	Drawn	1200	Air	98,000	62,000	22.0	56.0	223	29.2
48	Ni Cr Steel	.40	.65	.019	.031	.188	1.52	.55			a	As Received			112,630	86,300	21.5	57.5	230	24.0
49	Ni Cr Steel	.29	.29	.032	.028	.072	3.53	1.74			a	As Received			112,100	98,400	25.0	65.9	222	24.2
50	Ni Cr Mo Steel	.37	.69	.019	.019		1.72	.71	.33		a	Drawn	1200	Air	101,100	75,000	22.0	55.0	295	11.5
51	Cr V Steel	.45	.76	.032	.030			1.03		.19	a	Drawn	1200	Air	96,000	60,000	22.0	50.0	262	23.5

a: Actual Analysis e: Estimated Analysis *Maximum

TABLE V

TABLE V. CAST STAINLESS AND HIGH ALLOYED STEELS

No.	Alloy	Chemical Composition - Percentage of													Condition	Heat Treatments						Typical Physical Properties					Cavitation Loss in 16 hrs. mm³ at 20°C.
		C	Mn	P	S	Si	Ni	Cr	Mo	W	Fe	Cu	Co			Temp. Heated Deg. F.	Time Held Min.	Cooled in	Drawing Temp. Deg. F.	Time Held Min.	Cooled in	Tensile Strength Lbs./Sq. In.	Yield Point Lbs./Sq. In.	Elongation in 2 Inches %	Reduction of Area %	Brinell Hardness	
60	Stainless 12% Cr Steel	.06	.43	.015	.028	.38	.17	12.88						a	Quenched and Drawn	1800	60	Air	1200	120	Air	82,000	60,000	25.5	62.8	167	41.0
61	Stainless 12% Cr Steel	.06	.43	.015	.028	.38	.17	12.88						a	Quenched and Drawn	1800	60	Air	1040	120	Air	99,000	77,500	22.0	50.5	206	24.6
62	Stainless 12% Cr Steel	.06	.43	.015	.028	.38	.17	12.88						a	Quenched and Drawn	1800	60	Air	900	120	Air	128,000	89,000	15.0	26.0	248	12.0
63	Stainless 13% Cr Steel	.10	.67			.77		13.37						a	Quenched and Drawn	1875	90	Air	1200	120	Air	82,000	52,000	22.4	46.3	210	19.2
64	Stainless 17% Cr Steel	.10*	.45	.035*	.035*	.50*		17.50						e	Ingot Cropping							85,000	40,000	7.0	7.0	201	67.0
65	Stainless 20% Cr Steel	.24	.40			.78		20.08						a	Annealed	1550	120	Furnace				100,000	75,000	7.5	8.5	190	10.6
66	Stainless 20% Cr Steel	.24	.40			.78		20.08						a	Quenched and Drawn	1875	90	Air	900	120	Air					503	9.7
67	Stainless 12% Cr Ni Steel	.08	.49	.016	.021	.48	1.53	12.44						a	Quenched and Drawn	1800	60	Air	1200	120	Air	107,250	83,000	18.7	51.3	232	10.3
68	Stainless 12% Cr Ni Steel	.08	.49	.016	.021	.48	1.53	12.44						a	Quenched and Drawn	1800	60	Air	1040	120	Air	126,250	107,500	15.5	48.7	281	6.3
69	Stainless 12% Cr Ni Steel	.08	.49	.016	.021	.48	1.53	12.44						a	Quenched and Drawn	1800	60	Air	900	120	Air	164,000	125,000	12.2	29.7	363	5.0
70	Stainless 15% Cr Ni Steel	.05					.50	15.20						a	As Cast (Sand Mold)											220	113.0
71	Stainless 15% Cr Ni Steel	.07					.15	15.50						a	As Cast (Cast Iron Mold)											266	48.9
72	Stainless 14% Cr Ni Steel	.06	.39	.016	.021	.33	.98	14.72						a	As Cast (Sand Mold)											238	85.5
73	Stainless 14% Cr 1% Ni Steel	.05	.32	.016	.021	.35	1.14	14.48						a	As Cast (Sand Mold)											302	32.0
74	Stainless 14% Cr 2% Ni Steel	.05	.36	.018	.019	.31	2.02	14.30						a	As Cast (Sand Mold)											321	12.9
75	Stainless 14% Cr 3% Ni Steel	.07	.35	.016	.015	.40	3.36	14.30						a	As Cast (Sand Mold)											352	9.8
76	Stainless 13% Cr Mo Steel	.10	.47	.014	.027	.33	.12	12.88	.58					a	Quenched and Drawn	1800	60	Air	1200	120	Air	106,500	86,000	18.5	43.7	223	15.6
77	Stainless 13% Cr Mo Steel	.10	.47	.014	.027	.33	.12	12.88	.58					a	Quenched and Drawn	1800	60	Air	1040	120	Air	123,750	97,250	12.7	27.9	275	9.5
78	Stainless 13% Cr Mo Steel	.10	.47	.014	.027	.33	.12	12.88	.58					a	Quenched and Drawn	1800	60	Air	900	120	Air	143,500	111,000	9.7	12.4	316	7.7
79	Stainless 14% Cr Si Ni Mo Steel	.46	.41			1.53	34.58	14.52	.53					a	Normalized and Quenched	1875	90	Water				77,000	26,000	5.5	5.0	182	18.1
80	Stainless 18-8 Cr Ni Steel	.10	.40			.60	8.00	18.00						e	As Cast											135	11.8
81	Stainless 18-8 Cr Ni Steel	.08					8.25	18.50						e	Ingot Cropping							75,000	30,000	50.0	45.0	145	8.8
82	Stainless 18-8 Cr Ni Steel	.07	.72			3.43	10.06	20.61						a	Quenched	2050		Water				72,000	30,000	60.0	55.0	152	8.0
83	3.5% Si Monel	.03	1.00		.010	3.50	66.00				1.50	28.00		a	As Cast											217	11.4
84	Si Ni Cr Cu Steel	.65	1.00			2.36	18.86	2.65				7.00		a	As Cast							77,500	54,500	11.0	17.0	166	14.9
85	Stellite	1.00						30.00		4.00			65.00	e	As Received							66,000				382	2.1

a: Actual Analysis e: Estimated Analysis * Maximum

TABLE VI

TABLE VI. ROLLED STAINLESS AND HIGH ALLOYED STEELS

No.	Alloy	Chemical Composition - Percentage of													Condition	Heat Treatments			Typical Physical Properties						Cavitation Loss in 16 hrs. mm³ at 20°C.
		C	Mn	P	S	Si	Ni	Cr	Mo	W	Cu	Al	Co			Temp. Heated Deg. F.	Time Held Min.	Cooled in	Tensile Strength Lbs./Sq. In.	Yield Point Lbs./Sq. In.	Elongation in 2 Inches %	Reduction of Area %	Brinell Hardness	
90	Stainless 12% Cr Steel	.12*	.45	.025*	.025*	.40		12.25						a*	Annealed	1500		Furnace	75,000	40,000	32.0	70.0	142	46.7
91	Stainless 12% Cr Steel	.12*	.45	.025*	.025*	.40		12.25						e	Tempered	1150		Air	105,000	85,000	23.5	71.7	213	20.3
92	Stainless 12% Cr Steel	.12*	.45	.025*	.025*	.40		12.25						e	Tempered	1000		Air	145,000	133,000	19.0	64.0	285	8.3
93	Stainless 12% Cr Steel	.12*	.45	.025*	.025*	.40		12.25						e	Quenched	1800		Oil	180,000	162,000	15.0	51.0	401	3.5
94	Stainless 12% Cr Steel	.12	.48	.010	.014	.33		12.36						a	Annealed	1450		Furnace	87,000	60,000	31.2	73.9	178	88.9
95	Stainless 12% Cr Steel	.10*	.45	.035*	.035*	.50*		12.50						e	Tempered				110,000	80,000	25.0	71.0	248	15.6
96	Stainless 13% Cr Steel	.36	.42	.019	.022			13.23						a	Fully Annealed	1600	360	Furnace					161	80.9
97	Stainless 13% Cr Steel	.12*	.60*	.15*	.40*	.50*		13.50						e	As Received								157	72.3
98	Stainless 17% Cr Steel	.10	.32	.035*	.035*	.49	.20	17.59						e	Annealed	1400		Air	84,000	53,000	33.0	64.0	167	103.0
99	Stainless 18% Cr Steel	.10	.34	.029	.021	.46		18.12						a	Hot Rolled				91,000	50,000			207	16.6
100	Stainless 12% Cr 1% Ni Steel	.09	.48	.028	.019	.38	1.18	12.46						a	Hot Rolled and Annealed	1425	180	Furnace	175,000	135,000			159	73.0
101	Stainless 12% Cr Ni Mo Steel	.11	.51			.34	.16	12.23	.35					a	Annealed	1550	90	Furnace	80,000	45,000	32.0	73.0	156	42.7
102	Stainless 12% Cr Ni Mo Steel	.11	.51			.34	.16	12.23	.35					a	Tempered	1200	240	Air	120,000	90,000	22.0	70.0	223	15.1
103	Stainless 12% Cr Ni Mo Steel	.11	.51			.34	.16	12.23	.35					a	Hot Rolled				175,000	125,000	20.0	58.0	375	4.6
104	Stainless 12% Cr Ni Mo Steel	.11	.51			.34	.16	12.23	.35					a	Tempered	1800	30	Air	185,000	150,000	18.0	55.0	401	4.5
105	Stainless 12% Cr 1% Ni Mo Steel	.05	.95			.50	1.00	11.65	.49					a	Annealed				100,000	75,000			200	33.2
106	Stainless 12% Cr 1% Ni Mo Steel	.05	.95			.50	1.00	11.65	.49					a	Tempered	1800	30	Air	180,000	135,000	8.0	30.0	341	7.1
107	Stainless 13% Cr Ni Mo Cu Steel	.06	.85			.21	.82	13.48	.57		.77	.11		a	Tempered	1800	30	Air	160,000	120,000	12.0	40.0	316	9.7
108	Stainless 18-8 Cr Ni Steel	.05	.59	.025*	.025*	.41	8.96	18.69						a	Drawn and Quenched	1950		Water	95,000	40,000	60.0	70.0	144	14.6
109	Stainless 18-8 Cr Ni Steel	.07	.52			.39	9.44	19.76						a	Drawn and Quenched	2300	60	Water	90,000	30,000	70.0	65.0	128	26.7
110	Stainless 18-8 Cr Ni Steel	.07	.52			.39	9.44	19.76						a	Drawn and Quenched	1800	60	Water	100,000	35,000	65.0	60.0	151	14.9
111	Stainless 18-8 Cr Ni Steel	.08*	.50*	.025*	.025*	.50*	8.50	18.00						e	Annealed	1900		Water	93,000	30,500	58.0	67.0	153	13.9
112	Stainless 18-8 Cr Ni Steel	.14	.17			.34	8.06	17.65			.06			a	As Received				122,500	41,000	46.0	57.2	182	3.7
113	Stainless 24-12 Cr Ni Steel	.20*	1.25*	.025*	.025*	.50*	11.50	23.50						e	Annealed	2100		Water	96,000	46,000	62.0	69.0	139	8.6
114	Stainless 26-13 Cr Ni Steel	.06	.53	.014	.018	.30	13.32	26.20						a	Hot Rolled								161	4.1
115	20% Ni 8% Cr Steel	.43	.19			1.13	20.71	7.92						a	Hot Rolled				111,500	53,000	48.0	53.9	159	9.3
116	97% Ni Steel	.27	.75		.01	.05	97.13					.21		a	Hot Rolled								281	8.6
117	Stellite	1.10*						30.00			15.50		50.00	e	As Received								578	2.8
118	Stellite	1.10*						30.00			8.00		60.00	e	As Received								457	1.7
119	Stellite	1.00						30.00			4.00		65.00	e	As Received								486	0.9

a: Actual Analysis e: Estimated Analysis * Maximum * Minimum

TABLE VII

TABLE VII. FORGED AND COLD DRAWN HIGH ALLOYED STEELS

No.	Alloy	Chemical Composition - Percentage of									Condition	Typical Physical Properties					Cavitation Loss in 16 hrs. mm³ at 20°C.
		C	Mn	P	S	Si	Ni	Cr	Fe	Cu		Tensile Strength Lbs./Sq. In.	Yield Point Lbs./Sq. In.	Elongation in 2 Inches %	Reduction of Area %	Brinell Hardness	
120	Stainless 14% Cr Steel	.08	.34	.014	.023			14.76			a Forged and Oil Quenched	70,500	46,000	32.0	61.0	163	167.3
121	Stainless 17% Cr Steel	.08	.34	.014	.023			17.57			a Forged and Oil Quenched	74,500	48,000	33.0	63.0	180	114.5
122	36% Ni 11% Cr Steel	.35	.40			.60	36.00	11.00			e As Forged					169	13.9
123	35% Ni Steel	.25	1.00			.20	35.00				e As Forged					112	74.0
124	Monel	.17	1.11		.009	.03	67.43		1.43	29.80	a Cold Drawn	95,000	70,000	20.0		208	26.6
125	Inconel	.06	.96		.010	.06	80.28	12.69	5.81	.06	a Cold Drawn	145,000	134,000	10.0	35.0	262	27.0

a: Actual Analysis e: Estimated Analysis

Table VIII

Table VIII. Cast Brasses, Bronzes and Non-Ferrous Alloys

No.	Alloy	Chemical Composition - Percentage of										Condition	Typical Physical Properties					Cavitation Loss in 1 Hrs mm³ at 20°C.
		Cu	Sn	Zn	Mn	Si	Ni	Fe	Pb	Al	Mg		Tensile Strength lbs./sq.in.	Yield Point lbs./sq.in.	Elongation in 2 inches %	Reduction of Area %	Brinell Hardness	
130	Everdur	94.00			1.00	4.50						c	As Cast	50,000	25,000	22.0		82	258.0
131	Phosphor Deoxidized Cu Sn Mix	90.00	10.00									c	As Cast	40,000	18,000	12.0		54	157.0
132	Aluminum Bronze	89.00						1.00		10.00		c	As Cast	70,000	35,000	20.0		107	41.6
133	Gun Metal	87.50	8.00	4.00			.50					c	As Cast	40,000	20,000	25.0		61	391.0
134	P.M.G. Metal	78.00		2.00								c	As Cast	50,000	28,000	18.0		111	36.8
135	Hy-ten-sil Bronze No.4	68.00		22.00	4.00			3.00		3.00		c	As Cast	85,000	40,000	25.0	25.0	165	43.3
136	Hy-ten-sil Bronze No.3	67.00		22.00	4.00			3.00		4.00		c	As Cast	90,000	45,000	20.0	20.0	171	28.7
137	Hy-ten-sil Bronze No.2	66.00		22.00	4.00			3.00		5.00		c	As Cast	100,000	55,000	15.0	15.0	172	20.9
138	Hy-ten-sil Bronze No.2	66.00		22.00	4.00			3.00		5.00		c	Cast and Slow Cooled					161	53.0
139	Hy-ten-sil Bronze No.2	66.00		22.00	4.00			3.00		5.00		c	Chilled in Cast Iron Mold					217	16.0
140	Hy-ten-sil Bronze No.1	65.00		22.00	4.00			3.00		6.00		c	As Cast	110,000	65,000	12.0	12.0	204	22.0
141	Super Strength Bronze	64.00		24.00	3.00			2.00		5.00		c	As Cast	90,000	45,000	25.0	20.0	208	66.6
142	Super Strength Bronze	64.00		24.00	3.00			2.00		5.00		c	Chilled in Cast Iron Mold					226	25.9
143	Manganese Bronze	58.00		40.00	2.00							c	As Cast	65,000	33,000	25.0		114	252.0
144	Manganese Bronze	57.06		40.64	.15			1.26		.89		a	As Cast	66,500		42.0	93.0	96	187.0
145	Manganese Bronze	55.00	1.50*	38.00	3.50*			2.00*	.20*	1.50*		c	As Cast	65,000	30,000	22.0		129	135.0
146	Turbine Metal	56.00		36.00	2.00		3.00	1.00		1.00		c	As Cast	80,000	40,000	20.0		166	80.2
147	Turbodium Bronze	50.00		44.00	1.75		2.00	1.00				c	As Cast	70,000	35,000	17.0		154	101.0
148	Turbine Metal	50.00		46.00*			2.50*					c	As Cast	75,000	35,000	25.0		153	158.0
149	Aluminum Alloy No. Z14	.04				.14		.22		97.46	2.14	a	As Cast	25,000	12,000	9.0		49	1810.0
150	Aluminum Alloy No. 35676	.08				6.85		.27		92.49	.31	a	As Cast	32,000	22,000	4.0		74	3420.0

a: Actual Analysis c: Estimated Analysis *Maximum ^Minimum

Fig. 16—Fatigue Crack in Individual Grain of Cast Turbine Metal. (Spec. No. 148, Table VIII). Mag. 400 Diam.

The fact, however, should not be lost sight of that the effect of strain hardening may not necessarily overshadow the effect of the original hardness prior to testing or of the yield point, as noticeable from a comparison of the losses and the physicals of the austenitic 18-8 specimens Nos. 108 to 112 incl. on Table VI.

From the data given on Tables II, V and VI, it is also evident that the type of heat treatment is of utmost importance. This may best be shown by keeping the chemical composition constant and varying the treatment. Naturally the physicals are also influenced by the heat treatment, but what is perhaps of equal importance is that the heat treatments affect the grain structure. Care should be exercised not to reach premature conclusions regarding the grain size as the improvements in the physicals have naturally an appreciable effect in these various series of heat treated specimens. For this reason let us pass for an instance to Table VIII showing cast non-ferrous alloys.

It may be observed that specimens No. 135 and 146 show decidedly different losses in spite of the fact that the Brinell hardness and the yield point are of the same magnitude. At the same time microscopic analysis disclosed that the grains of both alloys are very similar in shape. The only marked differences found was in the grain size, the one of No. 135 being considerably smaller than that of No. 146. This seems to indicate a trend that the resistance to cavitation is increasing with decreasing grain size.

This characteristic may be further substantiated by Fig. 16. Here it may be noted that the failure is definitely transcrystalline. Secondly, the fatigue crack progressed until it reached the grain boundary, where its further progress seems to be retarded temporarily. The more grain boundaries are encountered in a certain distance the more difficult it may be for the crack to make headway. This may not only be true for fatigue cracks but also for those separations taking place in the zone of plastic deformation after the capacity to deform has been exceeded.

(*To be concluded in next issue*)

It is regretted that space limitations make it necessary to publish Mr. Mousson's paper in two installments. Reprints of the complete paper will be available after publication of the concluding installment in the October issue. The Bibliography for the complete article appears on the following page.

BIBLIOGRAPHY—PRACTICAL ASPECTS OF CAVITATION AND PITTING

1. "Pitting of Hydraulic Turbine Runners," Serial Report of the Hydraulic Power Committee (1925-1926), N.E.L.A.

2. "Report of Operating Experience with Units having Propeller Type Runners," Advance Reports for 43rd Annual Convention, 1933, The Canadian Electric Association.

3. "A Magnetostriction Oscillator Producing Intense Audible Sound and Some Effects Obtained," by N. Gaines, *Physics*, Vol. 3, No. 5, 1932, pp. 209-229.

4. "Progress Report on Cavitation Research at Massachusetts Institute of Technology," by J. C. Hunsaker, Transactions A.S.M.E., Vol 57, No 7, July, 1935, pp. 423-424.

5. Uber die Zerstörung von Werkstoffen durch Tropfenschlag und Kavitation" (Regarding the Destruction of Materials by Water Drop Impact and Cavitation), by J. Ackeret and P. De Haller, *Schweiz-Bauzeitung*, Vol. 108, Nr. 10, Sept. 5, 1936, pp. 105-106.

6. "Investigation of Corrosion Phenomena in Water Turbines," by P. De Haller, *Escher-Wyss News*, Vol. VI, No. 3, May-June, 1933, pp. 78-84.

7. "Schnellaufende Trubomaschien für Flüssigkeiten" (High Speed Turbines for Liquids), by W. Hahn, *Z.V.D.I.*, Vol. 75, Nr. 42, Oct. 17, 1931, pp. 1293-1296.

8. "Korrosion durch Kavitation in einem Diffusor" (Pitting due to Cavitation in a Diffusor), by H. Schröter, *Z.V.D.I.*, Vol. 76, Nr. 21, May 21, 1932, pp. 511-512.

9. "Korrosion bei Kavitation" (Pitting due to Cavitation), by H. Schröter, *Z.V.D.I.*, Vol. 77, Nr. 32, August 12, 1933, pp. 865-869.

10. "Werkstoffzerstörung bei Kavitation" (Material Destruction through Cavitation), by H. Schröter, *Z.V.D.I.*, Vol. 78, Nr. 11, March 17, 1934, pp. 349-351.

11. "Corrosion and Cavitation," *Mechanical Engineering*, Vol. 55, Nr. 12, Dec., 1933, pp. 766-767.

12. "Metallographische Untersuchungen zur Frage der Kavitations-Zerstörungen" (Metallographic Investigations regarding pitting due to Cavitation), by H. Schröter, *Z.V.D.I.*, 78, Nr. 40, October 6, 1934, pp. 1161-1162.

13. "Versuche zur Frage der Werkstoffanfressung durch Kavitation" (Experiments regarding the attack of materials due to Cavitation), by H Schröter, Mitteilungen des Forschungs-Institutes für Wasserbau und Wasserkraft, Munich, 1935, No. 3, pp. 31-52. See also *Z.V.D.I.*, Vol 80, Nr. 16, April 18, 1936, pp. 479-480.

14. "Phénomènes de la Cavitation" (Phenomena of Cavitation), by M. A. Tenot, Transaction Society of Civil Engineers of France, 1934.

15. "Cavitation Research," by J. C. Hunsaker, *Mechanical Engineering*, Vol. 57, No. 4, April, 1935, pp. 211-216.

16. "Cavitation at Tension Superficielle" (Cavitation and Surface Tension), by F. K. Th. Van Iterson, Proceedings Royal Academy of Science, Amsterdam, Vol. XXXIX, No. 2 and 3, 1936.

17. Round Table Discussions, Section on Hydraulic Plants, Third World Power Conference, Knoxville, Tenn., Sept., 1936.

18. "Flow of Water in the Casing of an Axial Flow Turbine," by K. Kaneshige, *Journal of the Faculty of Engineering*, Tokyo Imperial University, Vol. XVII, No. 8, pp. 153-182.

19. "On the Vibration of Draft Tube of Water Turbine," by S. Uchimaru and S. Kito, *Journal of the Faculty of Engineering*, Tokyo Imperial University, Vol. XVIII, pp. 213-270 and Vol. XIX, No. 4, pp. 71-106.

20. "Cavitation in and Consequent Vibration of the Draft Tube of a Water Turbine," by O. Miyagi, Technology Reports, Tohoku Imperial University, Vol. IX, No. 2, pp. 279-308.

21. "Tests on Erosion caused by Jets," by E. Honnegger, *The Brown Boveri Review*, Vol. XIV, No. 4, April, 1927, pp. 95-104. See also Vol. XXI, No. 1 and 2, Jan.-Feb., 1934, pp. 29-30.

22. "Rapid Erosion Tests Clarify Wear of Metals," by T. F. Hengstenberg, *Steel*—Oct. 17, 1932, pp. 21-23.

23. "Recent Developments in Steam Turbines," by C. R. Soderberg, *Mechanical Engineering*, Vol. 57, No. 3, March, 1935, pp. 165-173.

24. "Turbine Blade Erosion," by C. R. Soderberg, *The Electrical Journal*, Vol. 32, No. 12, Dec., 1935, pp. 533-536.

25. "Zerstörung Metallischer Werkstoffe durch Wasserschlag" (Destruction of Metallic Materials by Water Impact), by M. V. Schwarz and W. Mantel, *Z.V.D.I.*, Vol. 80, Nr. 28, July 11, 1936, pp. 863-867.

26. "Failure of Metals due to Cavitation under Experimental Conditions," by H. N. Boetcher, Transactions A.S.M.E., Vol. 58, No. 5, July, 1936, pp. 355-360.

27. "Die Zerstörung von Metallen durch Kavitation" (The Destruction of Metals through Cavitation), by H. N. Bötcher, *Z.V.D.I.*, Vol. 80, Nr. 50, Dec. 12, 1936, pp. 1499-1503.

Winners of Newspaper Advertising Contest for Electrical Gift Month Are Announced

WINNERS of prizes offered for the best newspaper advertisements tying in with Electrical Gift Month have been announced by Edison Electric Institute, which sponsored the contest jointly with a group of electrical manufacturers.

First prize in the division including cities of 250,000 or more population is awarded to Public Service Electric and Gas Company, Newark, New Jersey, Thomas H. Spain, Advertising Manager.

In the second division, cities from 100,000 to 250,000 population, the award goes to R. E. Ruse Furniture Company, Wichita, Kansas. Harry C. Ruse is Advertising Manager.

The award in the third division, cities from 25,000 to 100,000 population, goes to Blackstone Valley Gas and Electric Company, Pawtucket, Rhode Island; H. M. North, Supervisor of Advertising.

In the fourth group, cities under 25,000 population, the winner is Northwestern Public Service Company, Huron, South Dakota; Ward Dexter, Advertising Manager.

The four prizes, each consisting of electrical merchandise to the value of $100, were offered for "the most appealing newspaper advertisements featuring electrical housewares as wedding gifts," published in newspapers during May and June of this year.

Three of the prize winners used the June wedding theme in their captions, with effective copy and illustrations carrying the sales message. Mr. Spain led off with "Sense and Sentiment can go in double harness," and followed this alliterative heading with "From Romance to Reality: Housekeeping follows the Honeymoon, for Meals and Matrimony usually go together." This advertisement appeared in the daily newspapers of 20 cities in New Jersey during June.

Mr. North depicted a lovely bride before the altar, with the impelling caption, "Love, Honor and—Cook three meals a day!" This prize winner appeared in the *Pawtucket Times* on June 11.

Mr. Dexter offered a stirring appeal from young couples about to wed—"We who are about to marry speak frankly to you, our friends, about this question of gifts." He developed the thought that modern bridal couples want utility as well as beauty in their wedding presents, and expect their friends to recognize this modern trend with modern electrical appliances.

Mr. Ruse keyed his advertising to current news. His message was that "Coronation Day is every day" for electrical appliances and specified appliances, made by the manufacturer whom his company represents, as the ideal wedding gifts.

Kitchen Modernizing Movement Now Covers Entire Country

KITCHEN MODERNIZING BUREAUS increased in number 182 per cent between August 1, 1936, and August 1, 1937. The year's increase adds 100 new Bureaus to last year's 55. The annual report of the National Kitchen Modernizing Bureau, just released to its members, includes a list of local Bureaus in 40 states and the District of Columbia, and testifies to the rapid spread of the movement since the National Bureau was first established two years ago.

Of wide significance are the scores of cities and areas where Kitchen Modernizing by Electrifying is being actively promoted without the establishment of formal Bureaus. Territorial surveys indicate that Kitchen Modernizing activities are today no longer restricted to established Bureaus, but are being extensively carried on through an increasing variety of channels.

In New England, for example, nearly every utility company has adopted the Kitchen Modernizing program in some form for all of its properties. Sales are being recorded and promotional effort actively carried on in all the larger cities, and smaller scale activities are pushed aggressively in the towns and surrounding areas where no formal Bureaus exist.

Typical of the area coverage on Kitchen Modernizing by utility companies is the program of Connecticut Light & Power Company. All its salesmen and home service employees are trained in the Kitchen Modernizing approach, picked salesmen are assigned to this type of selling exclusively, and a well-rounded program of advertising, promotion, model kitchens and kitchen planning service is carried on.

Similar conditions exist in many states. The general adoption by utility companies of the Kitchen Modernizing activity as an integral part of their local merchandising programs has already made it state-wide in coverage repeatedly, whether or not this shows up in the list of established Bureaus.

As an instance of this the Report cites Miami, Florida, which has the only Electric Kitchen Bureau in that state, yet in no other state has the Kitchen Modernizing approach been so widely and actively employed with such brilliant sales results. The movement is state-wide; the utility companies which serve Florida have made Kitchen Modernizing their foremost merchandising endeavor for nine of the past twelve months.

In Georgia there are local Bureaus in the principal cities only. Due to the work of Georgia Power Company, however, Kitchen Modernizing activity covers the state. Alabama has only two Bureaus, both in Birmingham. One of them confines its activity to that city. The other serves as the core of a state-wide effort in which both the Alabama Electrical Dealers Association and the Alabama Power Company cooperate. This type of organization was set up in preference to establishing local Bureaus in the several smaller cities of the state as the more efficient approach to this population area.

In Wisconsin, Kitchen Modernizing is one of the approved activities of the state's association of utilities. Minnesota and the Dakotas are similarly banded together to promote Kitchen Modernizing by joint action of most of the utility companies.

In the more sparsely settled states, action of utility companies has established local Bureaus in every town and city of any considerable importance. In Washington, for example, there are 16 Bureaus in as many cities. Oregon has eight Bureaus, Montana has nine, and Idaho, seven.

The Report presents impressive evidence of the concrete results of this activity. Washington, D. C., for instance, reports 2,905 all-electric kitchens installed in homes and apartments up to August 1. Twenty-three utility companies, among the entire number which are active in Kitchen Modernizing, report a total of 25,647 electric kitchens sold on their lines during the year. Of these, 9,863 recorded the sale of an electric refrigerator, range and water heater; 15,784 the sale of an electric refrigerator and range. The total sales of this equipment exceeded $5,500,000.

Selling all-electric planned kitchens is by no means the sole objective of the National Bureau's program, however. It has proved itself invaluable as a new approach for selling individual pieces of kitchen electrical equipment. Sales of such individual items by the various companies reach a towering total.

Associated Gas & Electric Company, for example, using a similar ensemble selling plan, reports the sale of 31,303 electric refrigerators, 5,780 electric ranges and 2,434 electric water heaters between January 1 and May 1 of this year. In Brooklyn, N. Y., 1,416 electric refrigerators and 639 electric ranges have been sold as a result of the local Modernization Bureau's work. Sixty-two all-electric kitchens have been installed by Alabama Power Company, but individual sales of major appliances in its territory during the same period totaled 18,500 refrigerators, 5,700 ranges and 3,000 water heaters.

Total sales in the Georgia Power Company's territory for the first six months of 1937 (including both company and dealer sales), are 16,000 refrigerators, 3,700 ranges and 2,250 water heaters. Oklahoma Gas & Electric reports 9,812 refrigerators added to its lines during the year, and Public Service Company of Oklahoma added to its lines during the same period five all-electric kitchens, 6,325 refrigerators, 222 electric ranges and 22 electric water heaters. All of these companies have concentrated on the Kitchen Modernizing approach to their markets.

The Report devotes special attention to the advertising and publicity materials and other promotional aids which the National Bureau supplies, and to the use which local Bureaus are making of them. The cooperation of the manufacturers whose support and assistance have contributed greatly to the success of the program is appreciatively acknowledged.

Special attention is also devoted to the national kitchen planning contest now being conducted by *Better Homes and Gardens,* and to a contest conducted by the Red Star Milling Company, which offered five all-electric kitchens as prizes for the best essays on the value of its product. Thus both magazine and flour manufacturer not only capitalized on the nation-wide interest which the Kitchen Modernizing movement has aroused, but have contributed materially to publicizing it still further.

Byllesby Prize Paper

Meter Reading Work—A Function Of Customers' Accounting

By E. M. Wagner and L. M. LaPorte

E. M. WAGNER

This paper, which won the Second H. M. Byllesby Award for 1937, was written jointly by Merrrs. E. M. Wagner and L. M. LaPorte of The Milwaukee Electric Railway and Light Company.

Mr. Wagner is a graduate of the University of Illinois, receiving his B.S. degree in 1922 and his M.S. in 1923, both in accounting. He taught accounting courses at the University of Illinois and at Marquette University in Milwaukee for three years. He is a certified public accountant in the state of Wisconsin. He entered the service of the Milwaukee Electric Railway and Light Company on June 1, 1925, as supervisor of bookkeeping in the accounts receivable division, and in 1929 was promoted to his present position as assistant auditor of customers' accounts.

Mr. LaPorte received his education at the South Division High School in Milwaukee and later studied advanced accounting under a certified public accountant. His continuous employment with The Milwaukee Electric Railway and Light Company and its associate companies dates from April, 1920, to date. He was in charge of cost accounting during the construction of the Lakeside Power plant, and later was auditor of the Badger Public Service Co. and other smaller companies that were later merged with the Wisconsin Gas and Electric Co. In 1925 he was transferred to the Milwaukee office of The Milwaukee Electric Railway and Light Co. in charge of customers' accounts, where he supervised the installation of the stub accounting system. In 1932, he advanced to the position of assistant secretary and assistant treasurer, which position he now holds.

L. M. LAPORTE

IN some utilities, the meter reading and bill delivery groups are under the supervision of operating departments other than the accounting department. In The Milwaukee Electric Railway and Light Company and its associate companies, the meter reading work is a part of and is supervised by the accounting department. There are advantages which accrue from this arrangement that cannot be obtained through supervision of meter reading work by other operating departments. This paper is therefore prepared with the idea of describing the functions of meter reading and for the purpose of informing others interested in the entire duties of this phase of utility operation.

If all of the policies, practices, recommendations, regulations, wage incentive plans, promotional plans, and supervisory recommendations as described are followed, it will result in the work being performed efficiently, accurately, and harmoniously at a lower cost to the utility and the public served. It will also improve the public and employee relations which are so essential to the successful operation of the utility business. The results of years of continuous study and development of meter reading work by one utility should be available to the rest of the industry for their benefit.

A. General Results and Work Performed

The meter reading division of the Milwaukee office consists of the meter reading and bill delivery groups. As of December 31, 1936, there were twenty-nine meter readers and ten bill deliverers and one supervisor in the division. The company serves an area of 3,525 square miles embracing 174 communities with a population of 1,436,400, The types of service and the number of customers billed from the Milwaukee office are as follows:

1. Residential	185,518
2. Summer Cottage	3,767
3. Water Heating	2,303
4. Rural	3,057
5. Commercial Service—Lighting and Power	22,247
6. Large Users	3,820
7. Battery Charging, Cooking, and Refrigeration	2,557
8. Special Rate	7
9. Municipal	922
	224,198

About 85% of these accounts are located in the Milwaukee metropolitan area and the remainder of the accounts are for customers on farms and in small communities.

Based on newspaper data and on statements of representatives of other utilities who have called at the customers' accounting department, it is believed

that the number of meter readers employed and the cost of meter reading are unusually low. It is also believed that the manner in which the work is performed results in the efficient operation of the division.

1. *Costs are Low and Wages are High*

During 1936, 2,526,947 meters were read by the twenty-nine meter readers. This number does not include about 120,000 calls made by meter readers when they left a meter reading postal card because they were unable to gain entrance to the premises. There was a total of 2,646,947 meters read and postal cards left on customers' premises. The total cost of reading the meters and leaving postal cards was $60,445.51. This is at the rate of 2.28c. per call made by meter readers. These costs include meters read on foot in the metropolitan area and approximately 4,000 meters read by automobile in the rural territories.

Although the cost for reading the meters is low, the average wage for each meter reader is high. The average wage for the month of December, 1936, was $167.13. The large quantity of work performed at the low unit cost is partially attributable to the bonus plan. The beginning wage for a meter reader is $87.50 a month. When a new meter reader earns a bonus of 65% and makes less than three-tenths errors per 1,000 meters read for three consecutive months, his wages increase to $102.50 a month. This rate is increased $5.00 a month each year until the maximum wage of $112.50 is reached. In December, 1936, meter reading bonuses varied from 50.30% to 84.11% with an average of 63.99%. All routes are classed into one of four groups, depending upon the difficulties experienced in reading. These difficulties are measured in terms of the number of stops a mile and the difficulties encountered in gaining access to premises.

2. *Meter Readers are Promoted from Bill Delivery Work*

Each meter reader is originally employed as a bill deliverer. When an opening occurs in the meter reading group, the best bill deliverer is selected to fill the opening. This promotional plan is followed to create an incentive for each bill deliverer and at the same time to specialize the operations of the department as much as is economically possible. The wage rate for bill deliverers is different from that for meter readers. Meter readers who perform the more difficult work are given a higher wage and bill deliverers who perform the less difficult work are given a lower wage.

Bill deliverers are required to attend the public relation and technical meetings held for the meter readers. This acts as a pre-training course for the work they will do later on.

Sheet No. 16	"N"	Issued 1-33
Fortieth St.—300-699		233—17
Fortieth St.—1800-2499		243—30
Fortieth St.—See Grant Blvd.		249—15
Fortieth St.—2500-3959		244—24
Fortieth St.—4000-4399		1192— 1
Fortieth St.—4400-4799		276—36
Fortieth St.—5100-5199		274—26
Fortieth St.—5300-5599		281—37
Forty-first St.—100-199		3—45
Forty-first St.—200-599		233—17
Forty-first St.—2000-2899		247—21
Forty-first St.—2900-3899		249—15
Forty-first St.—3900-4399		1192— 1
Forty-first St.—4500-4799		276—36
Forty-first St.—5000-5199		274—26
Forty-first St.—5300-5599		281—37
Forty-first St.		68—17
Forty-first St.		1183—20
Forty-second St.—200-499		233—17
Forty-second St.—600-799		3—45
Forty-second St.—1300-1899		250—32
Forty-second St.—2100-3799		249—15
Forty-second St.—3800-4500		1192— 1
Forty-second St.—4520-4799		276—36
Forty-second St.—5000-5199		274—26
Forty-second St.—5400-5599		281—37
Forty-second Lane—3100-3199		253—22
Forty-third St.—1100-1399		250—32
Forty-third St.—4200-4299		1192— 1
Forty-third St.—4758-		276—36
Forty-third St.—5000-		274—26
Forty-third St.—5200-5499		281—37
Forty-fourth St.—100-425		1181—20
Forty-fourth St.—400-631		1141—20
Forty-fourth St.—1100-1399		250—32
Forty-fourth St.—2100-3499		248—21
Forty-fourth St.—3800-3999		251—24
Forty-fourth St.—4800-4899		274—26
Forty-fifth St.—500-698		1141—20
Forty-fifth St.—1100-1399		250—32
Forty-fifth St.—2100-3099		252—20
Forty-fifth St.—3100-3599		253—22

For—For

Fig. 1—Sample Page of Street Index.

3. *Meter Readers are Supervised in the Field*

The meter reading supervisor is furnished with an automobile which he uses in his work of supervising the meter readers. The purpose of the field supervision is to determine that the men are following the most efficient operating routine and that the men are conducting themselves satisfactorily from the standpoint of customer relations in accordance with standardized practices outlined in their job manual. The supervisor also determines that the men are not violating certain rules such as crossing lawns, smoking on duty, leaving doors open, etc.

4. *The plan of Operation in the Meter Reading Division Provides for Placing in a Meter Book the Number of Accounts for Which Meters can be Read in One Day*

The meter reader delivers at the office in the late afternoon or early morning his completed meter book and receives the next day's work. Each day's work consists of one-half hour of travel time and seven and one-half hours of work for books read on foot. The meter reading time for meter books read by automobile starts from the time the meter reader takes the automobile from the garage until the time the meter reader returns the automobile to the garage.

The advantages of one-day meter reading books are as follows:

a. Meter books are out of the office for a minimum period of time.

b. Meter readers must call at the office daily thus permitting close supervision.

c. The books consist of a convenient number of accounts to handle as a unit in the office operation.

d. The period of time between meter reading and figuring is uniform for all accounts.

5. *Arrangement of Accounts in the Meter Books Increases Meter Reading Efficiency*

The meter sheets for accounts are arranged in meter books in such a manner that meter readers, when reading meters, will travel on one side of the street in the morning and return on the other side in the afternoon. The meter sheets are placed in the exact order so the meter reading work can be done most efficiently. When a reading is not obtained in the morning and the meter reader is reading meters on the opposite side of the street in the afternoon, he crosses the street and attempts to obtain the reading which he was unable to obtain in the morning. The planning of routes in this manner reduces the travel time on each route.

The arrangement of accounts in meter books as described above permits the use of the most simple form of street index which is used in determining the route number in which a given address is located. When the route number is known, the meter sheet for the given address can be located quickly. One of the sheets of the street index is shown in Fig. 1 and serves to illustrate the extreme simplicity of cross-indexing addresses and route numbers for a large city when the practice of reading the meters on one side of the street in the morning and reading on the other side of the street in the afternoon is followed.

When a meter reading route includes

a large number of streets, such as when meters are read by squares or by reading both main and side streets in a route, a complex street index must be used to locate an account or an account must be located by the use of a map or a complete alphabetical index of all customers. The arrangement of meter books in the Milwaukee office eliminates this difficulty.

6. *Meter Readers Receive Thorough Instructions in Regard to the Duties They Must Perform*

Meter readers attend meetings twice each month. One meeting is devoted to a discussion of good public relation practices and the other to technical instructions in regard to their work. At the meetings held for technical instructions, new practices and instructions are discussed. At intervals, the instructions in the meter readers' manual are reviewed. The manual contains 62 pages of mimeographed material outlining every meter reader's duties in detail. It is especially valuable when new meter readers are trained.

The following summary of meter reading practices covers the general duties of meter readers as explained in their manual: Three of these duties are explained in detail following this summary.

1. Compare the meter number with the number of the meter appearing on the meter sheet.

This is done to obtain the reading for the corresponding meter.

2. Enter date, present meter reading and make the subtraction, and enter the consumption.

Office economy and accuracy are aided by reading all meters with a constant of one to the nearest even figure.

3. Compare current month's consumption with consumptions for previous months to determine if the current month's consumption is normal. The detailed duties of this work are described in another section in this paper.

4. Seal any unsealed equipment.

Meter readers are equipped with seals and sealers. All equipment, including the service box, is sealed to provide safety for the customer.

Whenever a piece of equipment has been found to be unsealed, a note is made on the reverse side of the meter sheet in a form provided for this purpose. If any piece of equipment has been found unsealed three times within six months, a special investigation is ordered. The investigation order is followed up by a representative of the electrical testing division who makes a thorough investigation to determine whether all consumption is being recorded on the meter. The practice of keeping customers' metering equipment sealed assists in preventing a large number of cases of diverted current by customers. It also assists in calling overloads and other fire hazards to the customer's attention.

When it is found that a customer has diverted energy, the meter sheet is marked "Check Seal." When meter readers read the meters, the sheets for which bear this notation, they are required to make a special check to determine that no energy is being diverted.

5. Report grounds or shorts to supervisor immediately by telephone.

6. Check the meter constant for all new meter reading sheets.

7. Report any equipment that uses energy but does not register on the meter.

8. Report polyphase meters when pilot lights are out.

9. Obtain a meter reading for every meter sheet in the meter book. Each meter sheet represents a service connection, and meter readers are required to obtain a reading even though the premises are unoccupied. If the meter sheet shows that there is a customer on service but the customer has moved, the meter reader attempts to determine the customer's new address and reports it to the office. If the meter sheet shows that the premises are unoccupied, but the meter shows consumption, the reader obtains the name of the new customer and reports it to the office. He also obtains and reports to the office the address at which the customer was formerly located.

10. See that customer is billed on the correct rate.

For example, if a meter sheet is for residential service and the premises are used for a business, such as a rooming house, the account is reported to the supervisor.

11. Report all unbilled service. If a meter reader finds that there is a service drop or service connection for a premises and there is no meter sheet, the meter must be read and the account reported to the supervisor. If the meter reader finds the loops have been closed and there is no meter, such cases must also be reported to the office.

12. Meter readers deliver circulars at low cost. A large amount of advertising material is delivered by the metermen for which they are paid a dollar a thousand pieces.

13. Accept keys for admittance to customer's premises on customer's written authority.

The Milwaukee Electric Railway and Light Company has about two hundred customers who have given the company permission to use their keys to enter their premises to read their meters. There are also a number of other customers who give the meter reader permission to use a key which is located on the customer's premises, or they give the meter reader permission to use a skeleton-key. In every case when the meter reader uses a key to gain access to a customer's premises, the meter reader must obtain a written authority from the customer. The customer signs the authorization and the meter reader brings the form to the office. A sample of the form is shown in Fig. 2.

FORM 305—4-37—1000

The Milwaukee Electric Railway and Light Company

ENTRY TO PREMISES AUTHORIZATION

TO THE MILWAUKEE ELECTRIC RAILWAY AND LIGHT COMPANY: DATE.....

I, the undersigned, hereby authorize The Milwaukee Electric Railway and Light Company to have its meter reader use a key and enter the premises at.....

for the purpose of obtaining the readings of electric service meters, access to be had between the hours of 7:30 a. m. and 6:00 p. m. Such authority is to continue until terminated by written notice.

IN PRESENCE OF: (SIGNED).....

.....

KEY TO ABOVE PREMISES RECEIVED

KEY NUMBER..... THIS.....DAY OF.....19.....

KEY KEPT AT..... (SIGNED).....

Fig. 2.

The authorizations are brought to the office where they are filed alphabetically and the customers' keys are kept in a key cabinet. When the meter book is given to the meter reader for the next month's meter reading, the key is removed from the cabinet and placed in the front of the book. When customers wish to have their keys returned, they are required to sign the authorization in the lower right corner. The authorization used as a receipt for the return of the keys is returned to the office and matched with the authorization which was issued when the key was obtained from the customer. The cancelled authorization and the receipt for the return of the key are kept on file for reference purposes. When customers move and do not ask that their keys be returned to them, the keys are kept on hand for one year, at which time they are delivered to the building division which uses them for miscellaneous purposes.

B. Three Profitable Duties of Meter Readers

The meter readers of The Milwaukee Electric Railway and Light Company perform three duties which result in substantial savings each year. These are as follows:

1. Postal cards are left at premises when access to meters cannot be gained.
2. Reminder or first delinquent notices are delivered by meter readers.
3. Fluctuations in consumption are investigated and reported to the office.

1. *Meter Reading Postal Cards*

In about 80% of the territory the meter sheets for accounts are arranged

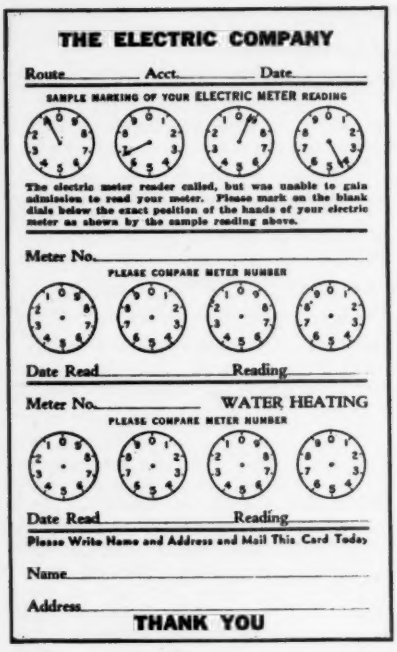

THE ELECTRIC COMPANY
Route Acct. Date
SAMPLE MARKING OF YOUR ELECTRIC METER READING
The electric meter reader called, but was unable to gain admission to read your meter. Please mark on the blank dials below the exact position of the hands of your electric meter as shown by the sample reading above.
Meter No.
PLEASE COMPARE METER NUMBER
Date Read Reading
Meter No. WATER HEATING
PLEASE COMPARE METER NUMBER
Date Read Reading
Please Write Name and Address and Mail This Card Today
Name
Address
THANK YOU

Fig. 3.

in the meter books in such a manner that meter readers, when reading meters, will travel on one side of the street in the morning and return on the other side in the afternoon. The meter sheets are placed in the exact order which can be followed to read the meters most efficiently. When a reading is not obtained in the morning and the meter reader is reading meters on the opposite side of the street in the afternoon, he crosses the street and attempts to obtain the reading which he was unable to obtain in the morning. When a reading cannot be obtained for a residential account in the afternoon, a meter reading postal card, as shown in Fig. 3, is left on the premises.

The meter readers attempt to read all the meters each month, but because of their inability to gain access to some premises, about 10,000 postal cards are left. Of these, approximately 8,500 are filled in by customers and placed in the mail. About 80% are received by the morning of the third working day after the meter reading date so that the readings from the cards can be transcribed to the meter sheets in time for the regular figuring operation for the entire route. The bills prepared for the remaining 20% of the cards are prepared and mailed from three to four days after the regular bills are issued, and bear the same regular monthly discount date. A few cards are received late and single special bills are rendered.

Meter reading postal cards are used because they provide the most economical method of obtaining meter readings for meters which cannot be read by the meter reader at the time the route is read. Some companies follow a plan of having a second call made at the premises on a date after the regular meter reading date to obtain readings of premises which were locked on the regular meter reading date. Under this plan it is necessary to travel over the entire territory twice to obtain all of the readings. To cover the entire territory twice is very expensive compared with the low cost resulting from the use of postal cards.

One case is known where in a locality of 20,000 customers, the time of one employee was required to obtain the "locked" or "skip" readings. When the use of postal cards was adopted, 60% of the cards were returned the first month. This percentage has been increasing each month. The adoption of the use of meter reading postal cards resulted in a saving of over a thousand dollars a year.

There are other advantages in the use of postal cards besides the monetary savings. Most customers fill in the meter readings and enter the dates on the same day the cards are left on the premises. The bills rendered based on the postal card meter readings cover a monthly period the same as those in which a reading was obtained by the meter reader at the scheduled reading date. When meter reading postal cards are filled in and mailed late, the customers know that the bills they receive are based on their own delayed meter readings and, therefore, if the bills are high because they cover more than the usual number of days, no questions are raised. When "skip" readings are obtained by meter readers it is necessary to render bills for longer than a monthly period, such bills being open to customers' complaints.

The Milwaukee Electric Railway and Light Company has used meter reading postal cards for many years and has found the practice to be entirely satisfactory.

2. *Reminder Notices*

The office working schedule for the customers' accounting department of The Milwaukee Electric Railway and Light Company is arranged so that the meter reading dates for each electric service route fall from five to seven days after the discount date. On the afternoon of the day preceding meter readings, the stub packs containing the unpaid charges in the routes are delivered to the addressograph group where the addressograph plates for the following accounts are removed from file:

a. Accounts on which there are electric service arrears which amount to $3.00 or more and which cover a present or a previous address or a combination of the two and on which there are no current bill payments.

b. Accounts having a combined total of merchandise and electric service arrears of $3.00 or more and on which there are no current bill payments.

c. Accounts for customers having several accounts on which no current bill payments have been made and one of which is over $3.00. In these cases all accounts receive notices regardless of the amount.

Impressions and the dates are then printed on reminder notices, and a sample of such notice is shown in Fig. 4.

The notice is of envelope form being open at each side and perforated at the

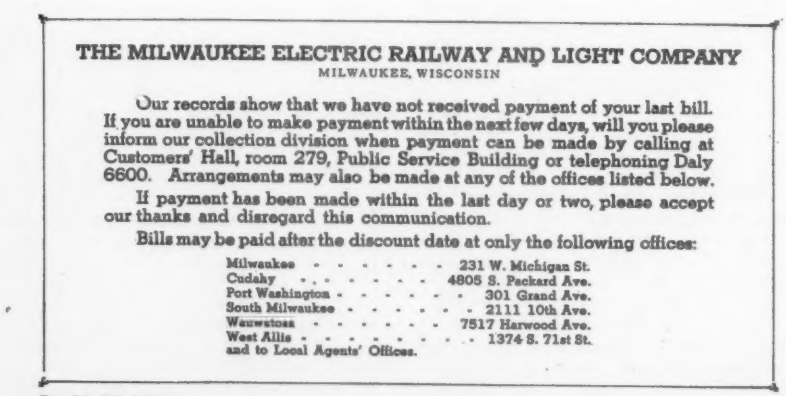

THE MILWAUKEE ELECTRIC RAILWAY AND LIGHT COMPANY
MILWAUKEE, WISCONSIN
Our records show that we have not received payment of your last bill. If you are unable to make payment within the next few days, will you please inform our collection division when payment can be made by calling at Customers' Hall, room 279, Public Service Building or telephoning Daly 6600. Arrangements may also be made at any of the offices listed below.
If payment has been made within the last day or two, please accept our thanks and disregard this communication.
Bills may be paid after the discount date at only the following offices:
Milwaukee - - - - - - - 231 W. Michigan St.
Cudahy - - - - - - - - 4805 S. Packard Ave.
Port Washington - - - - - - - 301 Grand Ave.
South Milwaukee - - - - - - - 2111 10th Ave.
Wauwatosa - - - - - - - 7517 Harwood Ave.
West Allis - - - - - - - - - 1374 S. 71st St.
and to Local Agents' Offices.
Form 212—6-35—100000

Fig. 4.

METER READERS' RULES FOR MAKING OR ORDERING METER INVESTIGATIONS

1. When meter constant is more than (1), do not investigate high, low or no consumption cases.
2. When satisfactory reason is obtained, enter reason in constant column but do not clip.
3. When satisfactory reason is not obtained, check reading, clip meter sheet, and underline current month's reading date.

A. Residential and Rural Accounts	Action
1. High Consumption	
50 kw-hr. or less consumption this month and last month	Do not investigate
52 kw-hr. or more consumption this month, and this month's consumption is more than twice the kw-hr. used last month, and this month's consumption exceeds any one month's consumption for the customer	Investigate
2. Low Consumption	
50 kw-hr. or less consumption this month and last month	Do not investigate
This month's consumption drops ½ or more and last month's kilowatt-hours were 52 kw-hr. or more	Investigate
3. No Consumption	
No reason stated in constant column for previous month(s)	Investigate
Reason stated in constant column or previous month(s)	Investigate every third month
Small garages (code 8 or 59)	Investigate only when a no consumption occurs in month of December
B. Commercial and Power Accounts	
1. High Consumption	
200 kw-hr. or less consumption this month and last month	Do not investigate
200 kw-hr. or more consumption this month and this month's consumption is more than twice the kw-hr. used last month, and this month's consumption exceeds any one month's consumption for the customer.	Investigate
2. Low Consumption	
50 kw-hr. or less consumption this month and last month	Do not investigate
This month's consumption drops ½ or more and last month's kilowatt-hours were 52 kw-hr. to 500 kw-hr.	Investigate
This month's consumption drops ¼ or more and last month's kilowatt-hours were 502 kw-hr. or more	Investigate
3. No Consumption	
Same as for residential and rural accounts.	

Fig. 5-a.

METER READERS' RULES FOR REPORTING CONSUMPTION, EQUIPMENT, AND PREMISES IRREGULARITIES

Clip meter sheet and underline current month's reading date when	Enter reason on meter sheet beginning in constant column of current month's billing line
1. Premises vacant and meter sheet shows customer on service.	1. "Vac"—new address of old customer
2. Premises occupied but meter sheet shows no customer on service.	2. "Occ"—name and previous address of new customer
3. Premises unoccupied and meter sheet shows no customer on service and meter shows a total consumption of 4 kw-hr. or more since date of disconnection.	3. "Cons"
4. Premises occupied by new customer. Name of old customer on meter sheet.	4. Name and previous address of new customer, and new address of old customer or, if name of new customer not obtained "new customer"
5. Metering equipment unsealed three times or more in the last six months and since last reported to the electric distribution department.	5. "Seals"
6. Cannot read meter (a) Apartment house. (b) Multi-family building. (c) Commercial account — unless customer requests that card be left. (d) Meter sheet marked "Do not leave card".	6. "Lk"
7. Customer is or will be out of town and (a) Customer does not want bills issued.	7. (a) "Out of town—Do not bill" on billing line for each month involved. Enter "Read" on the billing line for the month the customer will return.
(b) Customer wants bills sent to a forwarding address.	(b) "Out of town" on billing line for each month involved. Memo to senior clerk.
(c) No instructions received.	(c) "Out of town" on billing line for each month involved.
8. Meter sheet to be rerouted in opinion of meter reader.	8. No entry. Memo to senior clerk.
9. Access to meter cannot be gained but premises open.	9. Reason. If flooded, enter "Flooded" and depth of water.
10. Loops closed, premises occupied, and service being used.	10. (a) "Loops closed" if there is no meter. (b) "Disconnected" if meter is on premises but not connected.
11. Meter removed more than one month and meter number on meter sheet not crossed out.	11. "Removed"

Fig. 5-b.

METER READERS' RULES FOR REPORTING CONSUMPTION, EQUIPMENT, AND PREMISES IRREGULARITIES

Clip meter sheet and underline current month's reading date when	Enter reason on meter sheet beginning in constant column of current month's billing line
12. Repeated insistance by customer that meter reader leave a postal card though there is someone on premises.	12. "Cd"—Memo to senior clerk.
13. Permission to use key received or cancelled.	13. (a) When authorization is received, clip same to meter sheet. (b) When authorization is cancelled, prepare memo to senior clerk.
14. Meter sheet to be removed.	14. "Remove sheet" and reason (a) "No service drop". (b) "Building wrecked or moved". (c) "Service connected to meter number....., account.....". (d) "Short term contract discontinued and meter and service drop removed". (e) "Duplicate—same as account.....".
15. Pilot light out on a polyphase meter.	15. "Pilot light(s) Out".
16. Meter or time clock is or appears to be defective or to have been tampered with.	16. Memo to senior clerk.
17. Unable to reset time clock on a water heating account.	17. "Reset clock".
18. Time clock on water heating account reset and notation "R" placed in constant column for third consecutive month.	18. "R"
19. Actual consumption exceeds maximum consumption shown on meter sheets for water heating accounts.	19. "Excess Use".
20. Less Reading.	20. "Less Read". Check mark to show that meter reading was rechecked.
21. Miscellaneous—Condition of customer's service is such that meter reader desires to consult the senior clerk regarding the account— Includes cases such as Grounds. Three or four dial meter needing to be replaced because complete revolution of dials occurs oftener than once every four months. Not enough hot water. Complaint or request not settled.	21. Memo to senior clerk.
22. High, low, or no consumption and no adequate reason obtained. (See rules on investigations).	22. Check mark to show that meter reading was rechecked.

Fig. 5-c.

top so that it can be easily opened. The cost of the form is $1.12 a thousand.

It will be noted that no amounts appear on the notices. The practice of showing amounts on the notices was discontinued a few years ago and it is only on rare occasions that customers call and ask for the amounts of their bills. When the notices are received, the customers have their bills and prefer to present the bills instead of the notices when making payments. Whether the names and addresses of the customers and the date should be printed on the notices by addressograph or should be typed on them depends upon the volume. A study of the time required to remove the addressograph plates from file, print the notices and replace the addressograph plates, and of the time required to type the notices will determine which method should be followed.

The addressograph notices are delivered to the meter reading division between 3:00 p.m. and 4:00 p.m. where they are issued to the meter readers who will read the corresponding route.

The meter readers give the notices to customers if they can contact them. When they do not contact the customer, as in the case of single-family homes, the notices are left in a place where the customer will be sure to find them, such as under the kitchen door, on a table in the kitchen, if the door is open, or in the milk chute. In duplexes, the notices for the lower flat are placed under the rear door and the notices for the upper flat are placed at the top of the landing. Meter readers return notices for customers located in apartments. Such notices are mailed. The meter readers like the work of delivering reminder notices because they want to earn the additional remuneration. The meter readers receive $1.50 a thousand for delivering notices. During 1936, the meter readers delivered 169,000 notices at a cost of $253.50, compared with a mailing cost of $17.00 a thousand, or a total cost of $2,873.00. Under this practice we saved $2,619.50 during 1936.

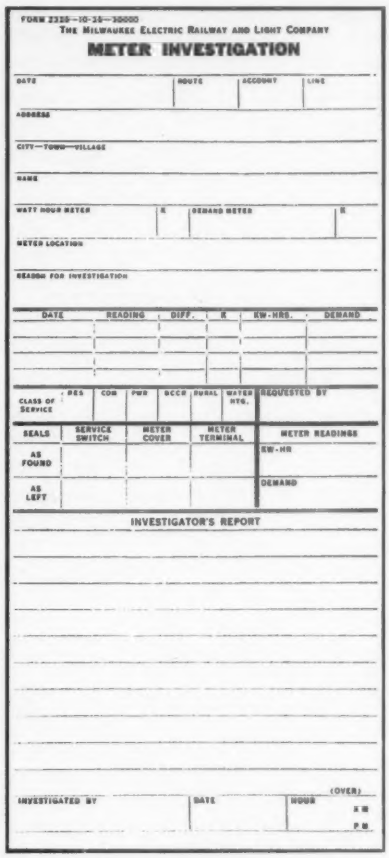
3. *Fluctuations of Consumption are Investigated and Reported to the Office*

The established practice has always been to investigate consumption and equipment and premises irregularities prior to rendering monthly electric service bills. Previous to last year, while meter readers were instructed to check their meter readings when the consumption showed a large increase or decrease compared with the previous months, and to obtain the reason for fluctuations, no action was taken when meter readers failed to determine why the customer's consumption changed, or when meter

readers failed to report other irregularities. When the account was figured on the fourth working day following meter reading, the figuring clerk in accordance with her instructions, ordered an investigation made. An investigation order was prepared and a member of the meter reading division made the necessary investigation. The investigation required several days to be completed and thus when the order was returned to the office, the bill was issued from three to seven days after the other customers in the neighborhood had received their bills. Frequently calls were received inquiring why bills were not received. It was costly to issue bills after the investigations were returned to the office, because such bills were issued in small quantities. These bills had to be mailed at an average postage cost of over 2c. each. compared with a delivery cost by a company bill deliverer of about a half cent a bill.

Under a new routine established in 1936, meter readers were given definite instructions as to when a consumption must be investigated. The rules followed by meter readers in investigating high, low, and no consumption and in reporting other irregularities are shown in detail in Fig. 5, a, b, c.

These printed rules are found in the back of each meter book so they can be referred to by the meter reader in case he is in doubt as to whether a particular consumption should be investigated. In cases where there is a fluctuation in consumption, the meter reader must interview the customer to determine the reason for the fluctuation, such as that an additional appliance has been used or the use of an appliance has been discontinued. In the case of no consumption the meter reader must determine if the meter has stopped or appears to be defective. When a consumption can be explained and there is no irregularity in the metering equipment, the reason for the fluctuation in consumption such as "used heater" is noted on the meter sheet. If the meter reader cannot find the explanation for the fluctuation a clip is placed on the meter sheet. A clip is also placed on the meter sheet when the conditions are such that a bill cannot be rendered as a result of the meter reader's call at the premises, as for example, when a meter has stopped or access cannot be gained to read the meter for a multi-family building. Whenever meter readers place a clip on the meter sheet, they also underline the current month's meter reading date to indicate that they have questioned the account.



FORM 2328—10-35—30000

THE MILWAUKEE ELECTRIC RAILWAY AND LIGHT COMPANY

METER INVESTIGATION

DATE | ROUTE | ACCOUNT | LINE

ADDRESS

CITY—TOWN—VILLAGE

NAME

WATT HOUR METER | R | DEMAND METER | R

METER LOCATION

REASON FOR INVESTIGATION

DATE	READING	DIFF.	R	KW-HRS.	DEMAND

CLASS OF SERVICE	RES.	COM	PWR	DCCR	RURAL	WATER HTG.	REQUESTED BY

SEALS	SERVICE SWITCH	METER COVER	METER TERMINAL	METER READINGS
AS FOUND				KW-HR
AS LEFT				DEMAND

INVESTIGATOR'S REPORT

(OVER)

INVESTIGATED BY | DATE | HOUR A.M. P.M.

Fig. 6.

Meter readers are held responsible for making all investigations and with definite rules for investigating fluctuating consumption, they know what work they are responsible for performing, and realize that their duties do not merely consist in obtaining meter readings.

When it is disclosed at the time of figuring that a meter reader has failed to make an investigation, or has failed to clip a meter sheet so that the meter reading office clerk could have ordered an investigation promptly after the meter book was returned to the office, an error report showing the errors made is prepared and this is shown to the meter reader so that he will guard against such omissions in the future. The errors decrease the meter reader's bonus earnings so that, of course, each meter reader is anxious to perform his work as accurately as possible. The results of the above plan are that meter readers order all investigations. Upon receipt of the meter books in the office, a meter investigation order is prepared. This is done by the meter reader supervisor placing a blank meter investigation order in the meter book at the account which is to be investigated. These meter books are then sent to the typists who know from the entries which are made on the meter sheets just how the meter investigation order is to be typed. The form of meter investigation used is shown in Fig. 6. These investigation orders are typed on the morning following the meter reading date and are then referred to the installation division of the electrical distribution department where the necessary check is made on the premises the second day after the meter reading. The installation division refers the investigation orders to the installers. Each installer makes investigations for the addresses located in his territory. By distributing the investigation orders to all of the installers, according to the address, the installers are able to complete their investigation by the evening of the morning on which the investigation orders are received. Due to inability to gain access to premises, some of the investigation orders are delayed; the number, however, is not large. At 8:00 a.m. of the third working day following the meter reading date, the orders are received in the office, and where the accounts as a result of the investigation can be billed, the accounts are figured along with all other accounts in the route and all customers receive their bills on the regular monthly date. The handling of investigations, according to the above routine, has been much more satisfactory than the routine which was followed in the past. Under the past routine the figuring clerks ordered the investigations at the time the books were figured. This meant that the bills for the investigated accounts went out a number of days after the regular bill delivery date. The present routine under which the bills for investigated accounts are issued at the same time that the bills for the route as a whole are issued, is most satisfactory and economical.

Adopting a plan of having the meter readers investigate abnormal consumptions while they are on the premises eliminated one special investigator who previously performed the work about five days after the meter reading date. The remaining accounts which have to be investigated because the meter reader was unable to obtain the information for the abnormal consumption are now being investigated by installers who are in the territory daily installing, disconnecting, and replacing meters. This has resulted in a saving to the company of approximately $2,500.00 a year.

Performance Tests on Non-Metallic Sheathed Cable for Underground Network Mains

By C. W. Pickells

New York and Queens Electric Light and Power Company, Long Island City, N. Y.

A paper presented at the Transmission and Distribution Committee Meeting, Chicago, May 5, 1937

NON-METALLIC sheathed cable for secondary mains appears to have several advantages among which are lower cost of cable, lower installation cost, some saving in subway cost, elimination of sheath corrosion, and better conditions for operating in case of trouble. The amount of savings which can be realized depends upon the life of the cable, which cannot be definitely established until longer field experience has been attained.

The New York & Queens Electric Light & Power Company has installed non-metallic sheathed cables in ducts on a large scale since 1928. Some few installations of non-metallic sheathed cable were put in service as early as 1919. Prior to 1934 most non-metallic sheathed cables for duct use were insulated with 30 per cent rubber compound and braid. They were bought under a specification for 30 per cent rubber compound, which was generally recognized throughout the industry and which was primarily designed to set up criteria for good 30 per cent rather than criteria for cable to be used for secondary mains in underground ducts.

The low voltage a.c. network had been operated only a short time when it became apparent that cable insulation for use on network mains should be resistent to high copper temperatures and should not give off combustible gases when subjected to an electrical fault. The manufacturers were requested to furnish a compound more suitable from the heating point of view but advised that requirements of the 30 per cent rubber specification prevented the obtaining of better heating characteristics in rubber compounds. They were not as yet ready to depart from rubber compounds for non-metallic sheath cable.

By 1934 the cable manufacturers were beginning to sense the increasing demand for non-metallic sheath cable and were beginning to offer a wide variety of constructions backed up by a wide variety of claims. After considerable discussion between the manufacturers and the New York and Queens Electric Light & Power Company it was decided that the Company would draw up a specification giving desirable characteristics for non-metallic sheath secondary cable and indicating the order of preference. Specifications for tests which the Company proposed to make on recommended constructions were also included in order that the Company might compare the various constructions offered, on a standardized basis and thereby determine which constructions came nearest to meeting all of the requirements.

The manufacturers were asked to submit constructions which they recommended for satisfying the requirements outlined in the specification. These constructions were tested in accordance with the specification and the results were used as the basis for determining which constructions were preferable for purchase. The performance tests were intended to represent individual conditions similar to those which obtain in the field, except that they were made more severe to give accelerated results. The cables were subjected to various conditions of over-heating, handling, exposure to water, acid, and alkali solutions, and transformer oil. Most of the cable installed on any system will seldom be subjected to all of these conditions but a construction should be capable of withstanding them if it is to be generally applied for secondary mains use. Even though these conditions may not obtain in the field, it seemed that ability to withstand this abuse should be a measure for comparing one construction with another, especially since no other criteria had been set up.

The performance tests, in the order of their approximate importance, are as follows:

1. Immersion in Tap Water.
2. Heat, Explosibility and Flame.
3. Immersion in Transformer Oil and Creosote.
4. Immersion in Acid and Alkali Solutions.
5. Accelerated Aging for Rubber Compound if used in the Construction.
6. Crushing and Cold Bend.

Inspection and Routine Tests

Before proceeding with the performance tests each cable was inspected closely to determine its general quality and workmanship. Each component part was measured and the insulation was tested for dielectric strength, tensile strength and elongation at rupture. These values were desired for comparison with similar values to be taken after certain of the performance tests were completed.

Twenty different cable constructions were offered for the complete series of tests. Later on, some manufacturers made supplementary tests on additional constructions following the same test procedure. Detailed results on the various manufacturers' constructions are not given in this paper. However, the range of values obtained in each test has been included in an effort to present an overall picture of the results obtained.

Type of Construction Submitted

All of the constructions submitted contained a rubber jacket, the composition of which was not known in all cases. Six cables had a combination of rubber for insulation and a special purpose compound for use as a sheath. The other constructions consisted of rubber insulation only. All cables had a braid covering, or equivalent, for mechanical protection. The thickness of insulation varied between 95 mils and 140 mils. Although the specification stipulated that the insulation should be clean-stripping this requirement was not met in several of the samples. The conductor in some samples showed sulphur corrosion and there were other evidences of poor manufacture. All cables were single conductor and contained 500 MCM copper.

Dielectric Strength

This test was performed in accordance with A S T M D-353. The samples, about 6 feet long, were bent into a U shape with a minimum radius of 1 foot and then immersed in water for 16 hours to saturate the braids. The breakdown voltage varied from 16,500 to over 48,000 volts, the lower value applying to insulation 95 mils thick and the higher to insulation 95 mils thick in one case and 110 mils thick in another. Most values were between 30,000 and 40,000 volts.

Fig. 1—Immersion Tests

Tensile Strength and Elongation

In accordance with A S T M D-353 test samples were cut from the insulation with 1" x ¼" die and then buffed, The values used are the average of three test results. The tensile strength of the rubber compounds in pounds per square inch varied between 1120 and 3720, that of the special compounds between 463 and 1400. The percent elongation (the *increase* in length expressed as a percentage of the 1" gage length) varied between 225% and 608%. Most of the compounds, including those now on the approved list, were between 1200 and 2000 lbs. per inch.

Performance Tests

1. *Immersion in Tap Water*

Two specimens of each construction, one with the covering on and one without the covering were immersed in a tank of tap water. The tank was 12 feet long, 2 feet wide and 1½ feet deep. The length of cable immersed averaged 13 feet and the overall length was 15 feet. Wooden separators maintained a clearance of ½ inch between adjacent cables to aid circulation of the water.

The specimens were in the tank 260 days. Current was passed through the cables on 254 of the days and was shut off on 6 for various reasons. A daily record of tank temperatures and ambient temperatures was kept by graphic thermometers. The daily load cycle was eight hours on and 16 hours off for the first 161 days and 12 hours on and 12 hours off for the remainder. For 100 days a current of 560 amperes was used giving daily minimum and maximum temperatures of approximately 17°C and 42°C respectively. The current was increased gradually to 725 amperes and was held there after the 158th day. The minimum and maximum daily temperatures were then 30°C and 72°C, approximately.

The resistance of the insulation of each sample was checked at intervals with a 1000-volt megger. More than half the samples showed infinity throughout the test and only 6 gave readings less than 1000 megohms. Had the equipment been available, the capacitance and power factor would have been measured also because a more accurate indication of the changes taking place can thus be obtained.

At the end of the immersion period each sample was given a visual inspection and then tested for dielectric, tensile and crushing strength as compared with its initial characteristics. The visual inspection showed the better constructions to be in good condition. The most noticeable effect was on those samples having composite insulation. In every case the outer layer was in poor condition, either swollen and separated from the rubber or hard and brittle. The comparison of tensile strength before and after indicated that this characteristic had decreased fom 20 to 70%. All the compounds except the poorest suffered little decrease in percent elongation.

2. *Heat Resistance*

The purpose of this test was to determine the relative resistance of the various cables to overheating resulting from medium and from extreme overloads. The values of current chosen, 2500 and 5000 amperes, represent approximately the overload imposed on network mains by fault conditions; the former being the current in the branches feeding a faulted section, the latter, the current in the faulted section. The cables were tested at the lower value of current for 12 minutes and at the higher value for 3 minutes, not because these periods have any significance as regards fault conditions but because some preliminary tests indicated that the better constructions would pass these tests and that the poorer would not.

Although crushing tests were made on the samples after being subjected to the overload, visual inspection was a much better means of judging the relative performance. When rating the cables on the results of the 2500 ampere test, softening or blistering of the compound was considered a defect. About 35% of the samples were in this category. None of the rubber compounds survived the 5000 ampere test without some softening action taking place. Although two of the synthetic materials were not visibly affected the rubber insulation beneath them was completely melted, probably because of the low thermal conductance of the former. The best overall performance was shown by 15% of the samples on which the rubber had just started to melt on inner surface and on which the braid was in good condition. The remainder showed up well on the first test but failed on the second.

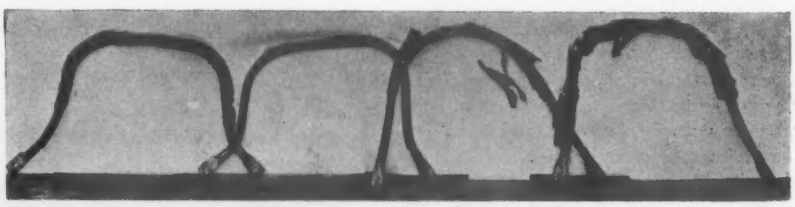


Fig. 2—Transformer Oil Test Specimens

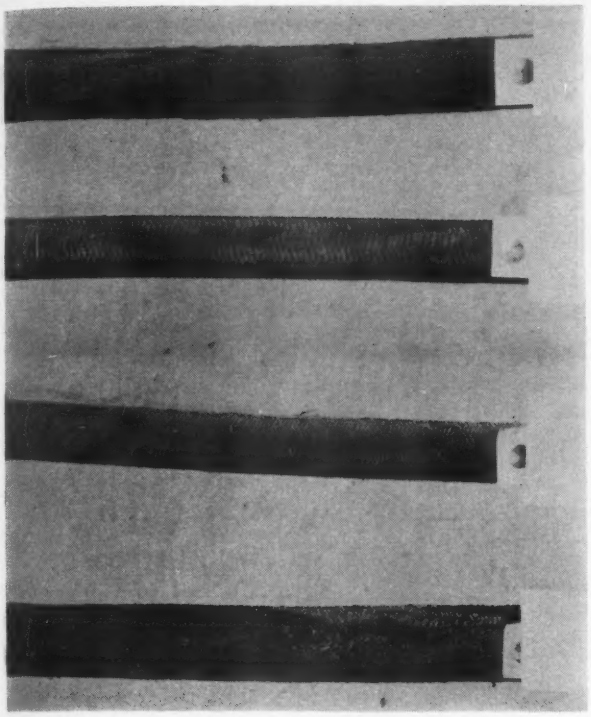


Fig. 3—Water Test Specimens

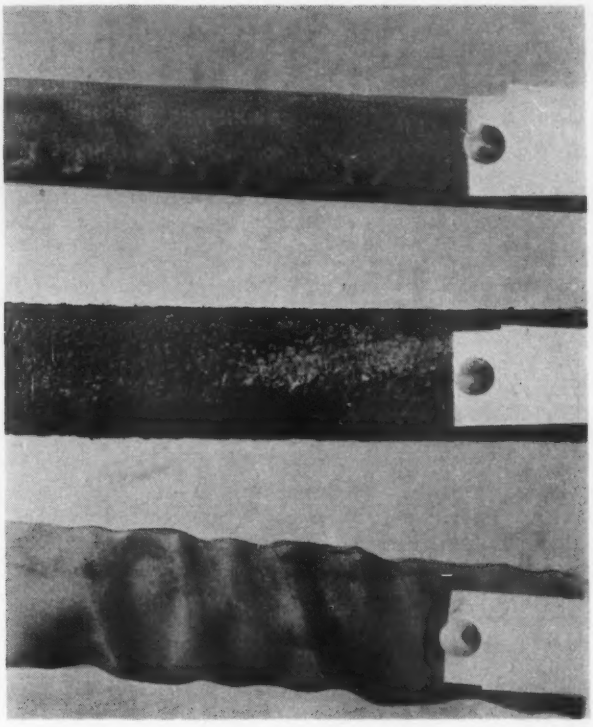


Fig. 4—Water Test Specimens

Explosibility

This test consisted of distilling destructively a sample of each construction at 1000°C and then mixing various quantities of the evolved gas and air in an explosion chamber. Both limits of explosibility were determined in this manner. In addition, the solubility of the gases in water and the quantity of gas evolved from one cubic inch of compound were determined. The upper and lower limits for the quantity of air rendered explosive by the addition of the gas evolved from one cubic inch of each compound were calculated.

The solubility of the gases in water did not exceed 2.5 per cent.

The variation in quantity of gas evolved and the explosive limits were as follows:

	Maximum	Minimum	Average	Per Cent Variation
Quantity of gas evolved—cubic feet per cubic inch of compound	0.51	0.31	0.43	46
Explosive Limits				
Lower limit—per cent	8.5	5.0	7.0	50
Upper limit—per cent	27.5	16.0	19.5	59
Range between upper and lower limit—per cent	19.5	9.0	12.5	84
Limits, expressed as Volume—in cubic feet, of explosive mixture formed by gas from one cubic inch of compound				
Upper	2.8	1.7	2.3	48
Lower	7.3	5.2	6.1	39
Range between upper and lower	4.9	2.8	3.9	54

Flame Resistance

The resistance of the cables to flame with coverings intact, was determined by applying the tip of the inner blue cone of a Bunsen burner flame to a piece of each cable. The pieces of cable were held in a vertical position. The flame was applied for 15 seconds. If the specimen burned for less than 15 seconds the flame was again applied at the end of the second 15 second period. If the specimen burned for more than 15 seconds but less than 60 seconds the next application was made at the end of the 60 second interval. This procedure was followed for 5 applications, the burning time being recorded for each application. If the burning time exceeded 60 seconds after any application of the flame the test was discontinued.

The minimum total burning time for any sample was 2 seconds while the tests on 2 samples were discontinued because the burning time after one of the applications exceeded 60 seconds. The burning time of the preferred constructions was 7 seconds or less.

3. *Immersion in Transformer Oil and Creosote*

Two 4-foot specimens of each construction, one with the coverings and one without, were immersed in transformer oil for 61 days. Similar specimens were immersed in creosote for a like period. A current of 280 amperes was passed through the specimens for 12 hours during each day, except when measurements were being taken. The temperature of the liquids varied between 0.5°C and 38.5°C with an average daily variation of 18°. Upon completion of the immersion period the insulating compounds were inspected and tests were made similar to those to which the water immersion specimens were subjected.

With few exceptions the braid coverings protected the insulating compounds and the external appearance of specimens with braids was generally good. On the other hand, the compounds on most of the stripped specimens were somewhat

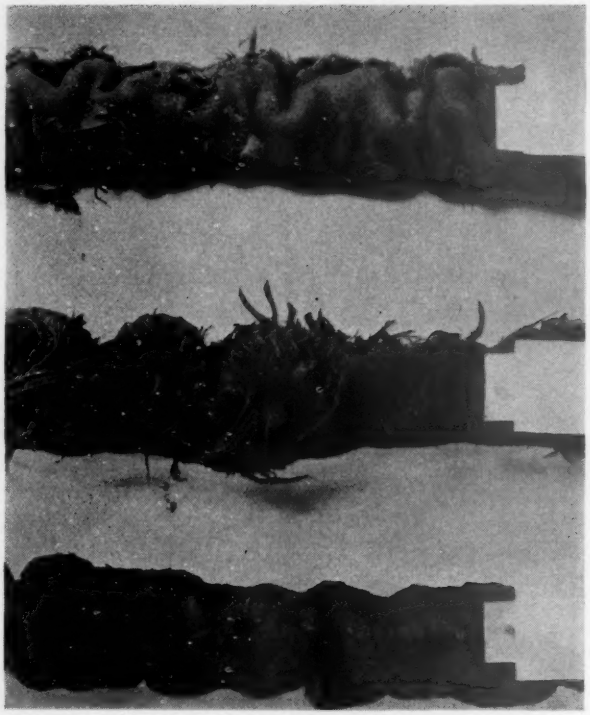


Fig. 5—Acid Test Specimens

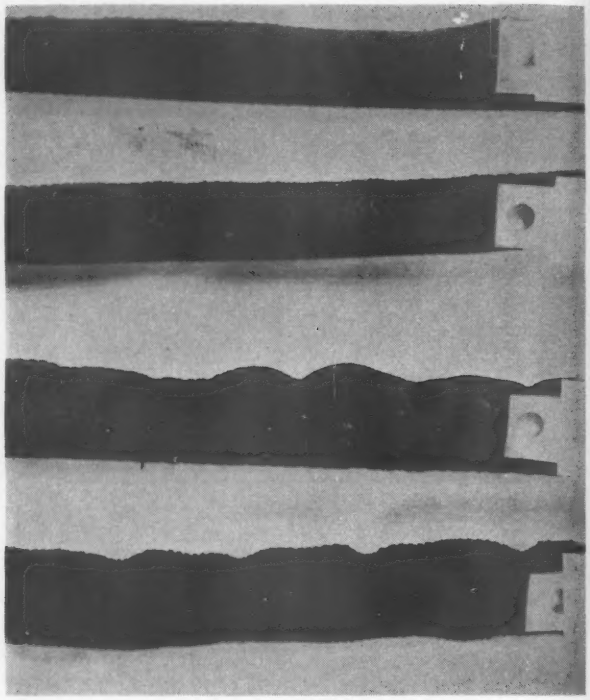


Fig. 6—Acid Test Specimens

swollen in both tests, the creosote test being the more severe. The insulation resistance of the oil specimens, both covered and stripped, exceeded 1000 megohms in all but 4 instances. The highest value for the creosote specimens was 700 megohms and the majority of the readings were below 100 megohms. The physical tests produced inconsistent results. However, it is believed that the better compounds could withstand some exposure to oil without electrical failure but that exposure to creosote or similar liquids would probably result in trouble in a relatively short time.

4. *Immersion in Acids and Alkalies*

These tests were conducted on 4-foot lengths in a manner similar to and for the same length of time as the water immersion tests. The acid was a 2% solution of acetic acid and the alkali was a saturated solution of calcium hydroxide. These concentrations were checked periodically and adjustments were made as required. The current circulated through the specimens was 280 amperes at the start but was increased in 3 steps to 362 amperes to give a daily maximum liquid temperature of approximately 55°C.

Periodic measurement of insulation resistance with the 100 volt megger showed infinity for 13 samples in the alkali solution.

In general all the specimens withstood the alkali test, although one specimen showed low resistance and no dielectric strength because the seam in the rubber jacket opened at several points. This defect also showed up in the water and acid specimens of this construction. The conductor in most of the specimens showed some evidence of corrosion.

Eight of the stripped specimens withstood the action of the acid on the rubber but the conductor of each was corroded in some degree. The rubber on the remaining specimens was swollen and wrinkled and the conductors were corroded.

Dielectric, tensile and crushing strengths were also measured but the results were not of much assistance in rating the cables.

5. *Accelerated Aging for Rubber Compounds*

To determine the aging quality of the compounds under accelerated conditions, specimens were placed in an oxygen chamber at a pressure of 300 pounds per square inch and a temperature of 70°C for 20 days. Enough specimens were provided so that aging after 5, 8 and 14 days could be determined. At the end of each interval tensile strength, elongation and set tests were made on 3 specimens and the results for each test were averaged.

The per cent of initial tensile strength retained after the 20-day period was 73.5% for the best rubber compound and 0 for the poorest compound. The best performance of the rubber compounds on the elongation test was a final elongation equal to 90% of the initial value, but some compounds could not be elongated at all after the aging period. One special compound had greater elongation after aging than before. The set test at the end of the 20-day period could be made on only 7 compounds as the others would not stretch the required amount. The best compound with respect to this particular test, increased its set 18 per cent. The other 6 compounds ranged between 37% and 85% increase. The final set, however, for any of these 7 compounds did not exceed greatly the usually accepted value of 3/8 inch in 2 inches.

6. *Crushing*

A crushing test was made on each compound to indicate its relative resistance to mechanical injury. The following procedure was used:

Each specimen, with covering intact, was placed in a compression testing machine having one flat jaw and one comparatively sharp jaw 1/16 inch wide. Compression was applied with a jaw speed of 1/20 inch per minute. Electrical connections were used to indicate

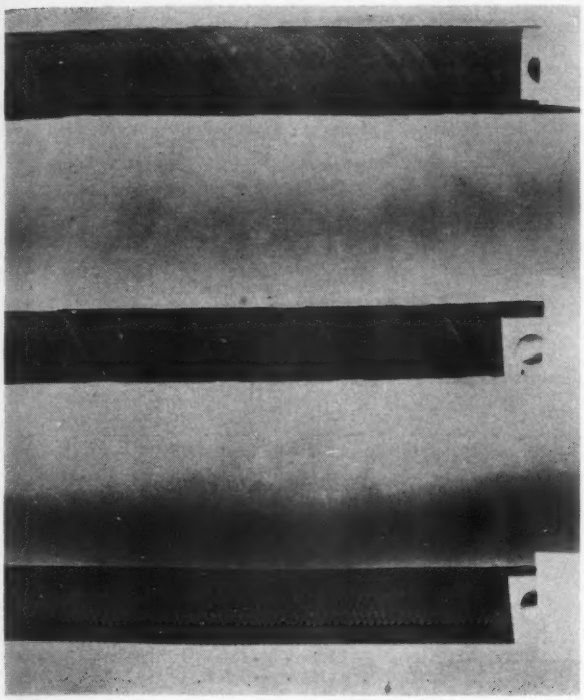


Fig. 7—Alkali Test Specimens

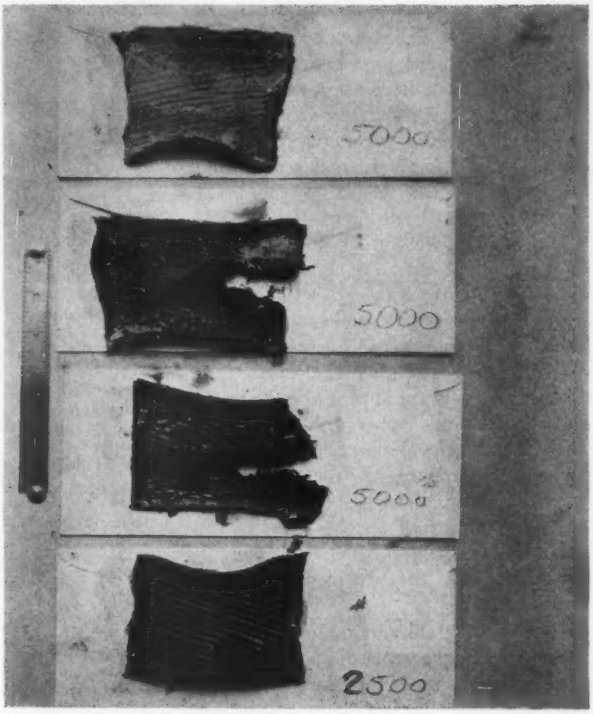


Fig. 8—Heat Test Specimens

when the jaw had cut through the insulation to the conductor. Three cuts were made on each specimen.

The minimum and maximum values obtained were 522 lbs. and 1801 lbs., respectively. The compounds which stood up best in the other tests were not comparable in this test, one giving a value of 616 lbs. and one a value of 1500 lbs., with others in between. The braid is the controlling factor here and its strength has no relation to the performance of the rubber compound.

Cold Bend

Straight lengths of the completely fabricated cables were exposed to a temperature of —10°C for a period of 2 hours and then bent in 1½ or more turns around a mandrel having a diameter equal to 4 times the outside diameter of the cable. They were next brought up to room temperature and tested for dielectric strength while in the bent position. Later they were examined for mechanical injuries.

With one exception all specimens had ample breakdown strength after bending. Most of the specimens showed no visible damage, the remainder showed splits in the braid or tape along the outside of the bend.

Water Absorption

Although a test for mechancial water absorption was not included in the performance specification water absorption tests were made on all compounds submitted. The specimens used had an exposed surface of approximately 20 square inches. The special compounds were separated from the rubber compounds and tested individually. Each specimen was freed of wax, tar, threads and other substances adhering to the surface and then scrubbed with a brush. They were rinsed and dried in circulating air at 70°C for 24 hours.

Each specimen was then weighed and immersed in distilled water at 70°C for 2 weeks. At the end of this period the specimens were removed, shaken, immersed in 95% alcohol for 2 seconds, shaken and blotted with lintless absorbent cloth. The specimens were now weighed again and the increase in weight in grams per square inch of exposed surface was computed. In computing the area of the inside surface strand indentations were taken into account.

The smallest gain for rubber compounds was 0.021 grams per square inch and the largest was 0.091. The smallest gain for special compounds was 0.098 and the largest 0.307.

Comparative Results

As stated at the beginning of this paper no construction tested was superior in all respects. A comparative rating of the better compounds is influenced to a considerable degree by the relative importance attached to the various tests by the individual. Three compounds appeared to be best suited for general underground use in ducts. Another compound has since been accepted as a result of tests made by the manufacturer in accordance with the specifications.

The following tabulation shows comparatively the overall performance of the preferred compounds:

Compound	Water Immersion	Heat	Explosibility	Flame	Oil	Creo.	Acid	Alkali	Aging	Water Absorb.
A	G	F	F	E	F	G	G	E	E	G
B	E	G	F	G	P	G	G	E	E	E
C	F	G	G	E	F	G	F	F	G	F

Key; E-excellent, G-good, F-fair, P-poor. (Comparative, not absolute, ratings)

Carrying out this comparison the 20 compounds were grouped roughly as follows: 5—very poor, 5—poor, 3—fair, 4—good, 3—preferred.

Conclusion

The non-metallic sheathed cables developed for secondary mains use by the various manufacturers in an effort to meet the requirements laid down in the

performance specifications described in this paper, are improvements over previous constructions, particularly from the point of view of heat resistance and explosibility. However, they are far from satisfactory cables for network use if, as in the past, network mains are to be expected to burn themselves clear. A feeling is growing throughout the industry that current limiting jointing facilities should be used on network mains, which will clear a faulty section whenever fault currents exceed the value which the cable is capable of carrying without distillation of the insulation. Should this new trend continue the work described in this paper will contribute little because the elimination of the heat resisting requirements by the use of such jointing facilities would make possible the development of another class of insulation primarily for the exclusion of moisture and for resistance against chemicals.

The photographs reproduced herein show the arrangements of tanks and cable specimens used for the immersion tests and the condition of the insulation of some of the specimens after the heat resistance test and the immersion tests.

Wire and Cable Standards Available

THE following fourteen wire and cable standards developed by a committee representative of all groups having an interest in the manufacture, use and inspection of wire and cable have been published by the American Standards Association and copies are available for sale:

Definitions and General Standards for Wire and Cable (C8.1-1932).....40 cts.
Class A 30% Rubber Insulation for Wire and Cable for General Purposes (C8.4-1936) .....20 cts.
Magnet Wire—(C8.5; C8.6; and C8.7-1936) Cotton-Covered Bound Copper Magnet Wire, Silk-Covered Round Copper Magnet Wire, Enameled Round Copper Magnet Wire.....30 cts.
Code Rubber Insulation for Wire and Cable for General Purposes (C8.11-1936) 20 cts.
Cotton Braid for Insulated Wire and Cable for General Purposes (C8.12-1936..20 cts.
Tree Wire Coverings (C8.16-1936)...20 cts.
Class A0 30% Rubber Insulation for Wire and Cable for General Purposes C8.17-1936) .....20 cts.
Weather Resistant (Weatherproof) Wire and Cable URC Type (C8.18-1936) 20 cts.
Tinned Soft or Annealed Copper Wire and Soft or Annealed Copper Wire (C8bl and C8b2-1928) .....30 cts.
Weatherproof Wire and Cable (C8k1 and C8k2-1932 .....20 cts.
Loose-leaf Binder $1.50
Set of 13 standards in binder..... 3.50

Members of Edison Electric Institute may purchase these standards at a discount of 20 per cent from the list price.

SALES—ELECTRIC REFRIGERATORS

(Household Models Only)

MONTH OF JULY AND FIRST SEVEN MONTHS OF 1937-1936

	Month of July 1937	Month of July 1936	Month of June 1937	First Seven Months 1937	First Seven Months 1936
Total United States	192,906	205,098	267,770	1,898,656	1,646,657
Maine	749	151	1,059	7,140	6,622
New Hampshire	621	(46)	999	5,659	5,623
Vermont	461	449	405	4,841	4,144
Massachusetts	7,278	6,092	7,851	74,478	63,217
Rhode Island	1,006	403	983	9,939	8,008
Connecticut	2,711	4,632	4,208	33,918	28,412
Total New England	12,826	11,681	15,505	135,975	116,026
New York	23,919	22,667	31,758	205,815	174,230
New Jersey	8,345	6,937	11,538	74,990	68,513
Pennsylvania	19,330	19,241	29,285	186,381	151,207
Total Middle Atlantic	51,594	48,845	72,581	467,186	393,950
Ohio	12,853	14,582	21,180	139,370	108,901
Indiana	5,522	6,774	8,219	54,898	47,946
Illinois	13,112	17,746	21,815	150,504	126,340
Michigan	12,232	10,536	15,264	102,269	81,244
Wisconsin	4,636	2,722	5,962	41,027	28,683
Total East No. Central	48,355	52,360	72,440	488,068	393,114
Minnesota	2,812	3,835	3,512	33,163	23,731
Iowa	2,321	3,856	3,833	29,930	26,987
Missouri	4,792	6,613	7,369	56,377	53,122
North Dakota	244	(124)	310	3,333	2,805
South Dakota	398	425	301	4,138	4,683
Nebraska	1,266	1,584	1,661	14,228	15,438
Kansas	1,703	2,045	2,403	22,305	20,440
Total West No. Central	13,536	18,234	19,389	163,474	147,206
Delaware	405	555	766	4,075	3,261
Maryland	2,858	945	3,418	23,260	17,881
District of Columbia	1,871	3,463	2,162	14,274	15,891
Virginia	2,833	3,002	4,539	30,106	26,280
West Virginia	1,702	2,441	4,210	24,026	22,727
North Carolina	2,790	3,068	5,888	42,281	33,311
South Carolina	1,584	1,620	2,888	20,153	15,708
Georgia	2,980	3,025	5,134	34,870	29,256
Florida	3,437	3,689	2,894	21,191	18,487
Total South Atlantic	20,460	21,808	31,899	214,236	182,802
Kentucky	2,057	2,860	4,778	25,858	22,888
Tennessee	2,056	1,632	3,858	31,111	25,790
Alabama	1,956	2,264	3,360	21,472	19,207
Mississippi	1,154	1,029	1,127	10,631	9,252
Total East So. Central	7,223	7,785	13,123	89,072	77,137
Arkansas	592	440	1,342	11,124	10,240
Louisiana	2,311	2,000	2,376	19,368	17,169
Oklahoma	1,792	1,412	2,505	19,529	17,495
Texas	7,988	8,164	8,291	75,025	68,067
Total West So. Central	12,683	12,016	14,514	125,046	112,971
Montana	1,142	1,333	960	7,749	7,971
Idaho	1,095	1,227	1,125	7,936	8,585
Wyoming	347	660	306	2,767	2,734
Colorado	1,495	1,186	1,503	12,875	12,331
New Mexico	442	193	408	4,089	3,392
Arizona	486	162	583	6,301	5,521
Utah	1,474	1,062	1,388	10,225	10,348
Nevada	74	451	287	2,252	2,274
Total Mountain	6,555	6,274	6,560	54,194	53,156
Washington	4,084	3,564	4,258	27,732	27,505
Oregon	1,843	1,885	2,261	14,563	17,814
California	13,747	20,646	15,240	119,110	124,976
Total Pacific	19,674	26,095	21,759	161,405	170,295

Figures based on report by the NEMA on Net Sales to Dealers and Jobbers.

Governor Aiken on Flood Control

(*Continued from page* 358)

part of their income from taxation of public utilities and power rights. In Vermont alone over $1,000,000 annually is paid into town treasuries by utility companies, and in addition to this the state collects several hundred thousand dollars a year in a tax on the production of hydro-electric energy. * * *

"Vermont is a small state," Governor Aiken said, "and was rich neither agriculturally nor industrially. It had nevertheless maintained a policy of paying its debts and of doing without those things which it could not afford.

"Vermont wants," Governor Aiken said in conclusion, "to be allowed to handle its local affairs in its own way, to enter into agreements with sister states on such matters as concern the states alone, to continue adhering to the principles of industry, self-reliance and self-respect, and to remain solvent."

Accident Prevention Committee Meeting To Be Held Oct. 9

THE EIGHTH MEETING of the Accident Prevention Committee will be held in Cleveland on Saturday, October 9. This date was decided upon in order to avoid a conflict with the Annual Congress of the National Safety Council which is to be held in Kansas City, Missouri, during the week of October 10. Details regarding the meeting room and program are not yet available.

This will be the first meeting of the Accident Prevention Committee under the chairmanship of Mr. L. M. Shadgett, who succeeds Mr. W. A. Buchanan. Chairman Shadgett plans to expand somewhat the present scope of the Committee and give consideration to problems relating to employee training and welfare.

One of the important problems which is being scheduled for consideration and discussion at this meeting is the testing of rubber protective equipment for linemen. Changes in distribution maintenance during the last few years have made necessary the reconsideration of the use of this type of equipment.

All representatives of power companies interested in accident prevention and safety work will be welcome to attend this meeting.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF MARCH 3, 1933

Of Edison Electric Institute Bulletin, published monthly at Philadelphia, Pa., for October 1, 1937.

State of New York.
County of New York.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Wilgar Coleman, who, having been duly sworn according to law, deposes and says that he is the Editor of the Edison Electric Institute Bulletin, and that the following is to the best of his knowledge and belief, a true statement of the ownership, management . . . etc., of the aforesaid publication for the date shown in the above caption, required by the Act of March 3, 1933,embodied in section 537, Postal Laws and Regulations . . . to wit:

1. That the names and addresses of the publisher, editor, managing editor and business managers are: Publisher, Edison Electric Insitute, 420 Lexington Avenue, New York City; Editor, Wilgar Coleman, 420 Lexington Avenue, New York City; Managing Editor, none; Business Manager, none.

2. That the owners are Edison Electric Institute, 420 Lexington Avenue, New York City, a mutual organization, not incorporated. Charles W. Kellogg, President, New York, N. Y.; F. H. Nickerson, Treasurer, New York, N. Y.; Bernard F. Weadcock, vice-president and Managing Director, New York, N. Y.

3. That the known bondholders, mortgagees and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages or other securities are: None.

Wilgar Coleman,
Editor.

Sworn to and subscribed before me this 15th day of Sept., 1937.

(Seal) Jessie R. Germond,
Notary Public, New York County.

(My commission expires March 30, 1938)

A Prophecy Spoken in Jest

SOME primitive electric cooking apparatus was available in the early "nineties"; specimens were shown at the Crystal Palace Exhibition in 1891. But in the year 1882 such things as electric cooking ranges, electric vacuum cleaners and electric washing machines could have been nothing more than a fantastic dream. Even if the cookers were conceivable, the vacuum cleaners and washing machines certainly were not. For this reason a flight of imagination published in a Berlin comic paper in 1882 is so remarkable that we appreciate the kindness of the Dacre Engineering Company in sending us a reprint which has been issued by our Swiss contemporary *Die Elektrizitat*. Here is a translation of the letter (alleged to be from a German maidservant) which was written for a Berlin comic paper 55 years ago:—

As you know, electricity has been discovered and through this discovery not only has Leipzigerstrasse been made light, but also the gloom of a maid's heart. For yesterday we read that one can cook and fry with electricity. If only that were really true, Herr Jeheimrath. Leave all other things alone and invent an electric cooking machine. With this you will raise our whole status on high. Think only of the trouble that cooking now causes us. Wood to cut, or coal to fetch from the cellar, etc. With an electric cooking machine, everything would be quite different. A press of a knob and the current flows round the top of the cooker—no smell or smoke—and one can quietly sit by it and read Goethe or Schiller's works. Also it does not burn the soup or meat. But there are other things besides cooking in household duties, so will you please invent an electric broom. One that is placed in the middle of the room and on pressing a knob it begins to turn round and go over the whole floor, under sofas, beds and in all corners, and must carry all the dirt to the dust bin. Also an electric dusting machine would be a pleasure. Finally, we would like a washing machine. One in which the dirty washing is inserted. Then let the current pass through it and take the washing out snow white, already dry and possibly ironed. P.S. Don't forget a plate washing and knife polishing machine.

We have omitted a few unnecessary sentences and possibly thereby we have spoiled the humorous *tout ensemble* of the maidservant's letter, but here is imagination of no less than five domestic electrical appliances all of which are in common use today.—*Electrical Times, London, Sept. 2, 1937.*

Retrial of Suit Against T.V.A. in October

ACCORDING to an Associated Press dispatch from Louisville, senior United States Circuit Judge Charles H. Moorman has formed a three-judge court for retrial of the suit of Tennessee Electric Power Company and eighteen other public utilities which assert the Tennessee Valley Authority was given an unconstitutional grant of Power by Congress.

The action was the first in the Sixth Federal Circuit, composed of Kentucky, Ohio, Tennessee and Michigan, under a recently enacted Congressional act providing that three Federal jurists including one circuit judge sit in hearings involving constitutionality of a Congressional measure.

Circuit Judge Florence E. Allen, Cleveland, and District Judge John D. Martin, Memphis, were designated to sit with Judge John J. Gore, Cookeville, Tenn. Hearing of the case was set tentatively for October 18. The judges will decide whether it will be held in Knoxville or Chattanooga.

The case was heard originally in the Eastern District Federal Court of Tennessee, where Judge Gore granted a temporary injunction against T.V.A. Later the Sixth Circuit Court of Appeals reversed the decision and remanded the cause for retrial.

PUBLICATIONS OF THE INSTITUTE

Pub. No.		*Date Issued*	*Price to Members*	*Price to Non-Members*	*Price to Foreign Countries*
E1	Rectifier Wave Shape	(4/37)	$0.40	$1.00	$1.10
E2	The Electric Light and Power Industry in 1936	(1/37)	.30	.75	.85
E3	Jointly Used Wood Pole Lines Specifications	(1/37)	.50	1.50	1.60
E4	Joint Use of Poles, 6.6 and 13.2 kv, Safety Features	(1/37)	.30	.75	.85
E5	Principles and Practices for Inductive Coordination, A.A.R. and E.E.I.	(1/37)	n. c.	n. c.	n. c.
E8	A-C Network Operation—1934-1935	(6/37)	.70	1.60	1.75
D1	The Objective Type Rates; 1933-1936	(4/36)	.80	2.00	2.15
D2	The Electric Light and Power Industry in 1935	(6/36)	.30	.75	.85
D5	Power Station Chemistry—1936	(7/36)	.20	.50	.55
D6	Boilers, Economizers, Air Heaters and Piping—1936	(9/36)	.60	1.50	1.60
D7	Combustion, 1936	(10/36)	.60	1.50	1.60
D8	Superposition of High Pressure Non-Condensing Equipment on Existing Power Stations	(10/36)	.25	.65	.75
D9	Principles and Practices in Grounding	(10/36)	.40	1.00	1.10
D10	Oil and Gas Engines—1935-1936	(10/36)	.40	1.00	1.10
D11	Turbines, Condensers, Feedwater Heaters and Pumps—1936	(11/36)	.60	1.50	1.60
D12	Air Conditioning—1936	(11/36)	1.20	3.00	3.15
D13	Engineering Reports of the Joint Subcommittee on Development and Research—Vol. III	(1/37)	5.00	10.00	10.00
D14	Engineering Reports of the Joint Subcommittee on Development and Research—Vol. IV	(1/37)	5.00	10.00	10.00
D15	Penstocks	(12/36)	1.00	2.50	2.65
D17	Cable Operation—1935	(12/36)	.60	1.50	1.60
C4	Boilers, Economizers, Air Heaters and Piping—1935	(7/35)	.60	1.50	1.60
C5	Turbines, Condensers and Feedwater Heaters—1935	(7/35)	.40	1.00	1.10
C6	Combustion—1935	(8/35)	.80	2.00	2.15
C7	Air Conditioning—1935	(9/35)	.50	1.25	1.35
C8	Oil and Gas Engines—1934-1935	(10/35)	.50	1.25	1.35
C9	Methods of Measuring Radio Noise	(11/35)	.15	.35	.45
C10	Symbols for Metering Diagrams	(12/35)	.10	.10	.10
C11	Cable Operation—1934	(12/35)	.60	1.50	1.60
C12	Twelve Messages on Accident Prevention in the Electric Public Utilities	(12/35)	.10	.10	.10
C14	Resuscitation Charts	(4/36)	1-10 copies .10 each 11-100 copies .05 each 101-1000 copies .04 each 1001 or more .03 each		
B2	Air Conditioning—1934	(5/34)	.75	1.85	2.00
B3	Condensers, Feedwater Heaters, Evaporators, and Boiler Feed Pumps—1934	(6/34)	.45	1.15	1.25
B4	Turbines—1934	(6/34)	.40	1.00	1.10
B5	Station Piping—1934	(7/34)	.60	1.50	1.60
B7	Oil and Gas Engines	(8/34)	.40	1.00	1.10
B8	Steam Generation	(8/34)	.60	1.50	1.60
B9	The Electric Light and Power Industry in 1933	(10/34)	.30	.75	.85
B10	Electrical Energy Diversion	(10/34)	.20	.50	.55
B11	Cable Operation—1933	(12/34)	.60	1.50	1.60
B12	A-C Network Operation—1932-1933	(12/34)	.40	1.00	1.10
A2	Station Piping	(8/33)	.60	1.50	1.60
A3	Turbines	(8/33)	.75	1.85	2.00
A4	Burning of Liquid and Gaseous Fuels	(7/33)	.30	.75	.85
A5	Power Station Chemistry	(7/33)	.40	1.00	1.10
A6	Pulverized Fuel	(8/33)	.75	1.85	2.00
A7	Stoker Equipment and Furnaces	(8/33)	.60	1.50	1.60
A9	A-C Networks Operation—1932	(7/33)	.20	.50	.60
A10	Cable Operation—1932	(8/33)	.45	1.15	1.25
A11	Load Area Development	(7/33)	.30	.75	.85
A12	Fault Locating Methods Used on Underground Cable Systems	(7/33)	.40	1.00	1.10
A13	Power System Wave Shape	(7/33)	.20	.50	.60
A14	Current Carrying Capacity of Impregnated Paper Insulated Cable	(7/33)	.25	.65	.85
A16	Load and Revenue Forecasting	(7/33)	.30	.75	.85
A17	Promotion of Home Air Conditioning	(8/33)	.20	.50	.60
A19	Hydraulic Governors	(8/33)	.20	.50	.60

The prices include mailing charges. Member prices apply to employees of company members of the Institute. Please send money order or check with order. Orders should be addressed to—

EDISON ELECTRIC INSTITUTE 420 Lexington Avenue, New York, N. Y.

POWER SALES ITEMS

AIR CONDITIONING

"How Much Power Will An Air Conditioning System Use?" by A. D. Marston. *Heating, Piping and Air Conditioning,* August, 1937, p. 513. Keeney Publishing Co., 6 North Michigan Ave., Chicago, Ill., Publishers.

"Practical Standards for Air Conditioning Calculations. Latent and Total Heat," by W. S. Bodinus. *Heating, Piping and Air Conditioning,* August, 1937, p. 488. Keeney Publishing Co., 6 North Michigan Ave., Chicago, Ill., Publishers.

"Silica Gel Air Conditioning System Serves Rotogravure Printing Plant," by H. E. Ryerson. *Heating, Piping & Air Conditioning,* August, 1927, p. 497. Keeney Publishing Co., 6 North Michigan Ave., Chicago, Ill., Publishers.

"Air Conditioning at the Agfa Ansco Film Warehouse," by H. W. Sachs. *Heating & Ventilating Magazine,* August, 1937, p. 31. The Industrial Press, 148 Lafayette St., New York City, Publishers.

"Conditioned Air—Its Opportunities and Problems," by E. W. Gray. *Heating and Ventilating Magazine,* August, 1937, p. 37. The Industrial Press, 148 Lafayette Street, New York City, Publishers.

Utility companies have actively promoted the sale of air conditioning equipment in many localities. Plan followed by the Oklahoma Gas & Electric Company.

"Air Conditioning the World's Largest Grain Market," by G. R. Bailey. *Heating and Ventilating Magazine,* August, 1937, p. 47. The Industrial Press, 148 Lafayette Street, New York City, Publishers.

There are problems in operating the air conditioning system in a large open space like the trading room of the Chicago Board of Trade.

CENTRAL STATIONS

"Operating Experience with Superposition," by R. Winters. *Electrical World,* July 31, 1937, p. 342. McGraw-Hill Publishing Co., Inc., 330 West 42nd St., New York City, Publishers.

Lessons learned on pulverizers, waterwalls, superheaters, economizers, blading scale, deslagging, erosion and warming-up period.

COMMERCIAL METHODS

"National Power Sales Advertising Gaining Favor," by R. D. Hayes. *Electrical World,* July 17, 1937, p. 207. McGraw-Hill Publishing Co., Inc., 330 West 42nd Street, New York City, Publishers.

Experience in promoting program indicates that electric utility industry is ready for concerted movement to retain and extend commercial and industrial business.

CONVEYORS

"Choose and Place Motors Right for Conveyors," by George H. Hall, Douglaston, New York. *Electrical World,* August 14, 1937, p. 68. McGraw-Hill Publishing Co., Inc., 330 West 42nd Street, New York City, Publishers.

Characteristics of different forms of conveyors.

DIESEL ENGINES

"Diesel Lubrication—A New Approach," by E. H. Hillman. *Power Plant Engineering,* August, 1937, p. 469. Technical Publishing Co., 53 West Jackson Blvd., Chicago, Ill., Publishers.

Lubricant selection must be based on a compromise between conflicting requirements and services.

"Automatic Diesel Controls," by H. E. Hill. *Power Plant Engineering,* August, 1937, p. 467. Technical Publishing Co., 53 West Jackson Blvd., Chicago, Ill., Publishers.

"Automatic Diesel Plant Confounds the Rate Maker." *Diesel Power,* August, 1937, p. 584. Diesel Publications, Inc., 192 Lexington Ave., New York City, Publishers.

Diesel plant which does not need constant attendance is fully automatic and produces power for 1c. per kwh.

"Nordberg Gas-Diesel at Lubbock, Texas," by L. H. Morrison and Orville Adams. *Diesel Power,* August, 1937, p. 559. Diesel Publications, Inc., 192 Lexington Ave., New York City, Publishers.

Description and results of nine months operation of the gas Diesel engine.

"Economics of the Gas-Diesel." *Diesel Power,* August, 1937, p. 558. Diesel Publications, Inc., 192 Lexington Ave., New York City, Publishers.

Gas Diesel which may be changed to oil operation depending on cost of fuel.

DIESEL LOCOMOTIVES

"Diesel Electric Locomotives," by F. H. Craton, General Electric Co., Erie, Pa. *Iron and Steel Engineer,* August, 1937, p. 33. Association of Iron & Steel Engineers, 1018 Empire Bldg., Pittsburgh, Pa., Publishers.

Advantages of the Diesel electric locomotive in industrial switching and transfer work.

ELECTRIC MOTORS

"Study Motor Requirements for Plant Change-over," by R. C. Allen, Westinghouse Electric & Manufacturing Co., Boston, Mass. *Electrical World,* August 28, 1937, p. 32. McGraw-Hill Publishing Co., Inc., 330 West 42nd St., New York City, Publishers.

Analyze machine loading and grouping for production—study selection of motor and control—arrangement of drive in planning an increase in plant capacity.

FUEL OIL

"Fuel Handling." *Diesel Power,* August, 1937, p. 566. Diesel Publications, Inc., 192 Lexington Ave., New York City, Publishers.

Six articles on proper practice of fuel handling from storage to engine.

INDUSTRIAL ELECTRIFICATION

"Industrial Electrification." *Electrical World,* August 14, 1937, p. 92. McGraw-Hill Publishing Co., Inc., 330 West 42nd St., New York City, Publishers.

Five items which contain ideas for power sales:

Cordage reel uses torque motor drive.
Welding cuts weight of truck 20 per cent.
Automatic breakers pay their own way.
Unbalance raises cost of motor operation.
Capacitor location affects motor voltage.

"Industrial Electrification." *Electrical World,* August 14, 1937, p. 66. McGraw-Hill Publishing Co., Inc., 330 West 42nd St., New York City, Publishers.

Four items which contain ideas for power sales:

Modern furnaces cut alloy melting costs.
4-speed drive needs little machine space.
Recording meters a check on production.
Wire mill adopts electro-galvanizing.

PURCHASED POWER

"Sometimes It Pays Not to Generate Power," by P. Morse. *Power Plant Engineering,* August, 1937, p. 455. Technical Publishing Co., 53 West Jackson Blvd., Chicago, Ill., Publishers.

Simplex Wire and Cable Co. plant at Cambridge, Mass.

STEAM TURBINES

"Modern Steam Turbines," by A. G. Darling, General Electric Co., Schenectady, N. Y. *Iron and Steel Engineer,* August, 1937, p. 39. Association of Iron and Steel Engineers, 1018 Empire Bldg., Pittsburgh, Pa., Publishers.

Advances in design of new turbine generator power plants.

WELDING

"Welding Society Published Standard Welding Symbols." *Heating, Piping and Air Conditioning,* August, 1937, p. 487. Keeney Publishing Co., 6 North Michigan Ave., Chicago, Ill., Publishers.

"Largest Welded Stack at Fisk Station." *Power,* September, 1937, p. 507. McGraw-Hill Publishing Co., Inc., 330 West 42nd Street, New York City, Publishers.

Self-supporting, brick-line, 220-ft. stack uses new type joint which combines shop and field welds for economical construction.

Cycles and Service

(*Continued from page* 354)

electric utility situation was full of badness and that dire punishment by the Government was the only solution. This storm of public sentiment is subsiding but the waves have not ceased to roll.

In riding out of the storm the electric utilities wisely confined themselves to concentrating their energies upon the fundamental of their existence—service. It has been many times observed in the past that the cure for the evils of democracy is more democracy, clearly intimating that probably the evils in question arose from departing from true democracy. Likewise the evils which sprang up in the utility field can be cured only by the most complete devotion to that ideal of service which is the center and soul of the utility business. This course the utilities have followed consistently in recent years and have done so with marked success.

Consider what the electric utility industry has accomplished during the last decade, most of which has been during the longest and deepest depression in the business history of our country. It has gained 6,000,000 customers. It has electrified 800,000 more farms. It has invested $5,000,000,000 more in its plant, thus adding 11,000,000 kw. to its capacity. It has increased the average consumption of electricity in the home from 428 to 750 kw. per annum and has reduced the average cost of a kwhr in the home from 6.98c to 4½c; and all of this in spite of its taxes during the decade having gone from 9% to 15% of gross earnings.

This is an answer to Government criticism which the public can understand and which I believe it does understand and appreciate. Our own reaction to the accomplishments of our industry in the last decade should not be mere elation but should be a convincing demonstration of the essential importance of service and should lead us to a renewed devotion to the determination to make our service reach in the future continually higher and higher standards of performance.

Let us therefore consecrate ourselves to attaining to the highest levels of service, confident in the belief that it is the only way to get and to maintain stable prosperity.

CONVENTIONS AND MEETINGS

SEPTEMBER

8-10	Pennsylvania Electric Association, Bedford Springs Hotel, Bedford Springs, Pa.
13-14	Wisconsin Utilities Association, Transportation Section, Lawsonia Hotel, Green Lake, Wis.
13-15	Rocky Mountain Electrical League, Estes Park, Colo.
16-17	Empire State Gas and Electric Association, Saranac Inn, Saranac Lake, N. Y.
17-18	Public Utilities Association of West Virginia, Greenbrier Hotel, White Sulphur Springs, W. Va.
24-25	Wisconsin Utilities Association, Accounting Section, Lawsonia Hotel, Green Lake, Wis.
27-30	American Gas Association, Cleveland, Ohio.
27-30	Illuminating Engineering Society, Greenbrier Hotel, White Sulphur, W. Va.

OCTOBER

1	American Gas Association, Cleveland, Ohio.
1-2	Prime Movers Committee, Purdue University, Lafayette, Ind.
9	Accident Prevention Committee, Cleveland, Ohio.
11-12	Electrical Equipment Committee, Chamber of Commerce Grill, Terminal Tower Building, Cleveland, Ohio.
11-15	National Safety Council Congress, Kansas City, Mo.
12-13	Transmission and Distribution Committee, Chamber of Commerce Grill, Terminal Tower Building, Cleveland, Ohio.
17-20	National Electrical Wholesalers Association, Cleveland, Ohio.
21-23	Indiana Electric Association, French Lick Springs Hotel, French Lick Springs, Ind.
24-29	National Electrical Manufacturers Association, Chicago, Ill.
27-29	National Paint, Varnish and Lacquer Association, Cincinnati, Ohio.

NOVEMBER

8-10	Accounting Committee conclave, Book Cadillac Hotel, Detroit, Mich.
11-13	Wisconsin Utilities Association, Electric Section, Commercial and Technical Divisions, Pfister Hotel, Milwaukee, Wis.

DECEMBER

6-10	American Society of Mechnical Engineers, New York, N. Y.

JANUARY

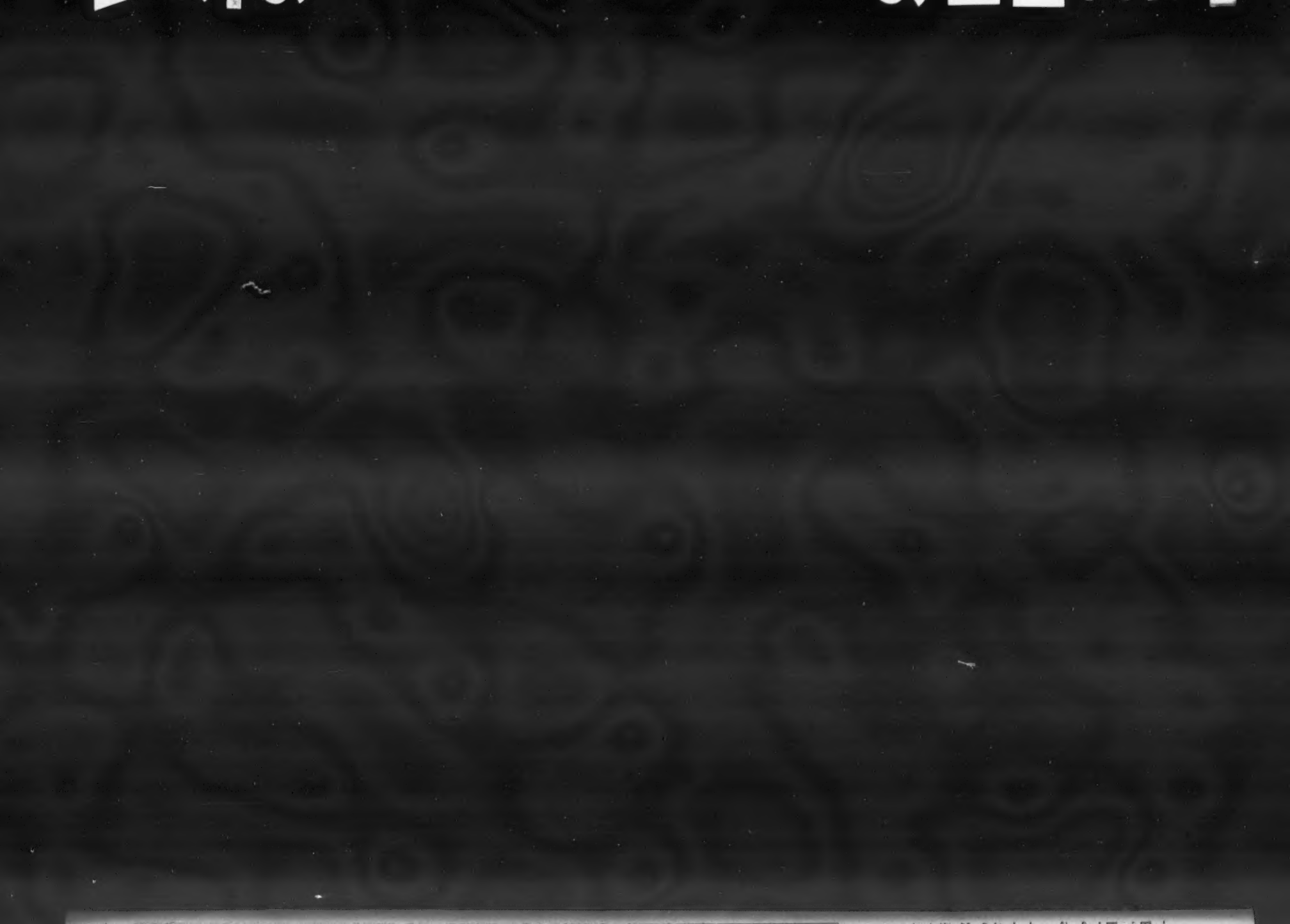
19-21	American Society of Civil Engineers, New York, N. Y.
24-26	National Warm Air Heating and Air Conditioning Association, New York, N. Y.
24-28	American Institute of Electrical Engineers, New York, N. Y.
24-28	International Heating and Ventilating Exposition, New York, N. Y.

Electrical Standard of Living Program

(*Continued from page* 360)

homes selected nationally which best meet the ten specifications. All awards will be made irrespective of cost or size of home entered, thus making it possible for small houses to compete on an even basis with larger ones.

The activity is not designed to force building, but to encourage those who plan to build or modernize during this period to take advantage of up-to-date knowledge and equipment.

A second type of activity to be carried on as part of the electrical standard of living program is educational in nature and is pointed at those who have no immediate construction or modernization in prospect. It will also be sponsored locally by utility companies. Participants will be furnished with informative material detailing the advantages of complete home electrification, including kitchen treatment, scientific lighting, planned home wiring, heating and air conditioning, and will be invited to describe briefly why electrical living appeals to them.

The "better living" activity will be spread over a ten-week period this year, from September 27 to December 4. Every week during the period General Electric will award ten $200 prizes, and at its completion, two fully-equipped homes, costing $12,000 and $8,000 respectively.